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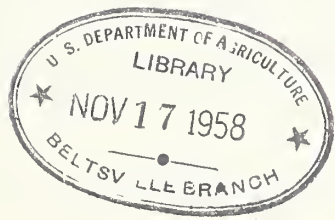
PROGRESS IN SOIL AND WATER CONSERVATION RESEARCH

a quarterly report

Soil and Water Conservation Research Branch
Agricultural Research Service
U. S. DEPARTMENT OF AGRICULTURE
No. 10

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The Branch will publish the results of experiments reported here as promptly as possible. Some of the results carried in these quarterly reports are simultaneously in the process of publication.

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The Soil and Water Conservation Research Branch works in cooperation with the State Agricultural Experiment Stations.

Report for July-September 1956
Issued March 1957

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IRRIGATION

<u>Utah</u>

WATER REQUIREMENTS ESTIMATED FOR ASHLEY CREEK UNIT

Wayne D. Criddle, Logan.--Representatives of the Bureau of Reclamation, Utah Agricultural Experiment Station and Agricultural Research Service undertook to develop certain specifications and water requirements for irrigating lands in the Ashley Creek Unit of the Upper Colorado Project of Eastern Utah. Values established by the group included the following:

1.   <u>Cropping pattern</u>. The records of previous cropping practices in the area and the judgement of crops specialists formed the basis of the cropping pattern used in estimating water requirements of the unit. Only four major crops are considered and the percent of the area devoted to each is given in Column 2 of Table 1.

2.   <u>Consumptive use</u>. The estimated consumptive use values for each major crop for the frost-free and pre and post frost-free growing period are given in Table 1. These were based largely on a study made in the area by Utah Agricultural Experiment Station and the Soil Conservation Service during the period 1948 to 1950.

3.   <u>Effective precipitation</u>. Ninety percent of the growing season precipitation during the ten lowest years of record was considered as supplying effective soil moisture for crop production (Column 6, Table 1).

4.   <u>Net consumptive use</u>. The difference between the total consumptive water requirement and the effective precipitation is considered as the net consumptive use requirement. This is shown in Column 7 of Table 1 as 20 inches for the growing season.

5.   <u>Conveyance losses</u>. Some water losses always occur in conveying it from the point of diversion to the farm. For Ashley Valley conditions, total seepage and administrative losses were estimated to be 18 percent.

6.   <u>Farm efficiency</u>. The major factors affecting water use efficiency on the farm are the kind of soils, slope of the field, the kind of crops grown and the skill used by the irrigator. The estimated farm efficiency in the use of irrigation water in the Ashley Valley is 55 percent.

7.   <u>Number of irrigations</u>. The number of irrigations required for crops in the Ashley Valley will be dependent upon the seasonal consumptive requirement of the crop, the water holding capacity of the soil within the root zone of the crop and the minimum level to which the moisture content of the soil is allowed to reach between irrigations. With these factors in mind, it is estimated, as an example, that from four to five irrigations per season will supply the soil moisture requirements of a corn crop grown on a medium textured soil in this valley.

8.   <u>Diversion requirement</u>. The amount of water diverted from the source for irrigation of cropland must include the consumptive use requirements of the crops grown, plus all conveyance and application losses. The estimated annual gross diversion requirement for irrigated cropland in the Ashley Valley, as shown in Table 2, is 3.7 acre-feet per acre.

Table 1.--Consumptive irrigation water requirements for Ashley Creek Unit, Upper Colorado River Project, Eastern Colorado

| Crop | Percent of area | Consumptive use[1] | | | Effective precipi- tation[2] | Net consumptive irrigation requirement |
		Frost-free period	Pre and post frost-free period	Total growing period		
		Inches	Inches	Inches	Inches	Inches
Alfalfa........	37	21	4	25	3	22
Pasture........	26	19	4	23	3	20
Corn..........	9	19[3]	------------	19	2	17
Small grain, etc..........	28	17	1[4]	18	1	17
Average	---------	----------	------------	-------	---------	20[5]

[1] From table 11, page 22, Utah Agricultural Experiment Station Special Report No. 8, modified by Engineering Conference at Salt Lake Region 4 USBR Office on September 10, 1956.
[2] Ninety percent of precipitation in lowest ten growing season of record.
[3] Adjusted from 17" to 19" to allow for maturity of corn if desired. Most of the measured data are for silage corn only.
[4] Added to take care of early planted grains that consume water before the end of the freezing season.
[5] Weighted average.

Table 2.--Summary gross irrigation water requirements Ashley Valley, Utah

Net consumptive use	20	inches	1.67 feet
Irrigation efficiency	55	percent	
Farm delivery	36.4	inches	3.03 feet
Conveyance losses	18	percent	
Diversion requirement	44.4	inches	3.70 feet

California

ATMOMETER DATA CORRELATE WITH EVAPORATION AND CONSUMPTIVE USE

Dean C. Muckel, Berkeley.--Atmometers operated during the summer of 1956 at evaporation stations in the San Francisco Bay region show a close correlation with data obtained from a Weather Bureau type pan. The relationship established by the University of California at Davis, namely that evaporation from a Weather Bureau type pan in inches is equal to 0.0051 evaporation from a white atmometer in cubic centimeters, appears to apply in the Sacramento-San Joaquin Delta area. The relationship found at Joice Island and Mandeville Island in the delta area as well as that found at Davis is illustrated in Figures 1 and 2.

Also, it appears from the limited data now available that the use of water by tules has a close relationship with the difference in evaporation between black and white atmometers. On Figure 3, cumulative use of water by tules is plotted against cumulative difference in evaporation between black and white atmometers for the Joice Island station.
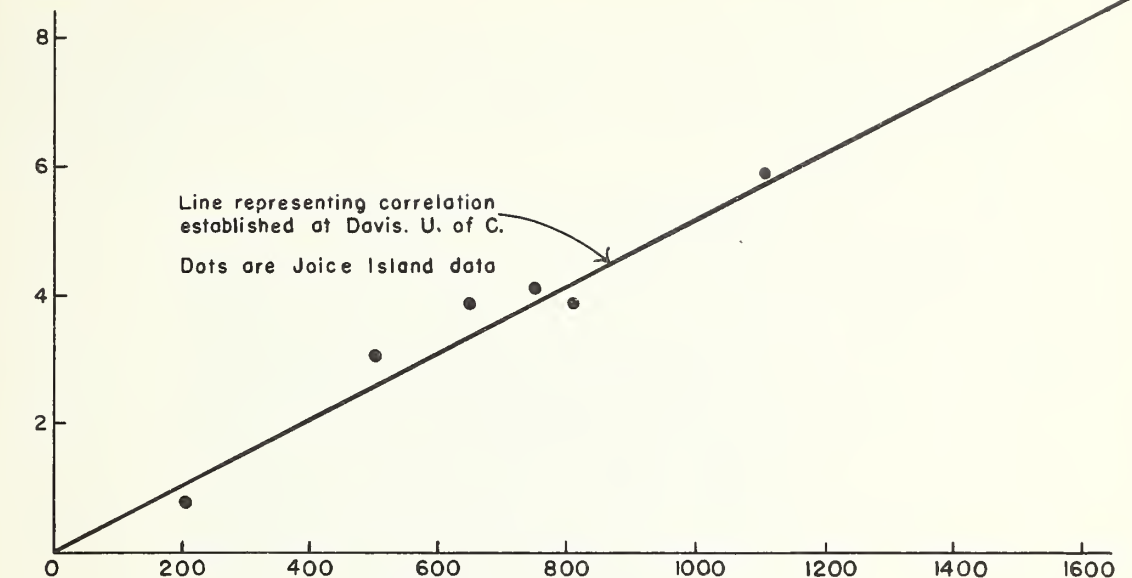
Figure 1. --Relationship between evaporation from a Weather Bureau type pan and a white atmometer, Joice Island, Calif.
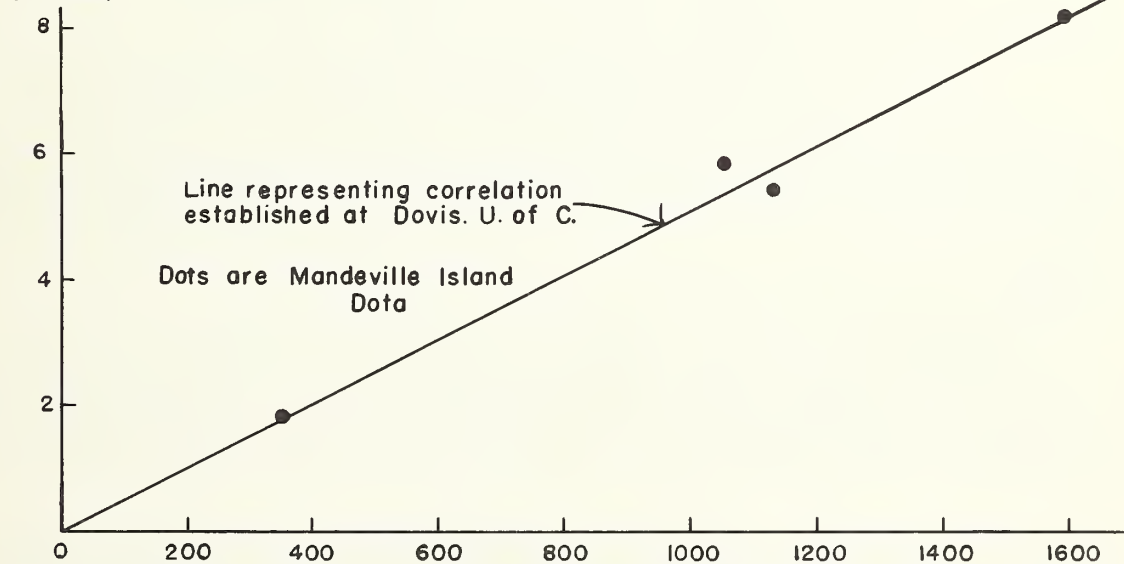
Figure 2. --Relationship between evaporation from a Weather Bureau type pan and a white atmometer, Mandeville Island, Calif.

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Cumulative use of
water by tules
(inches)
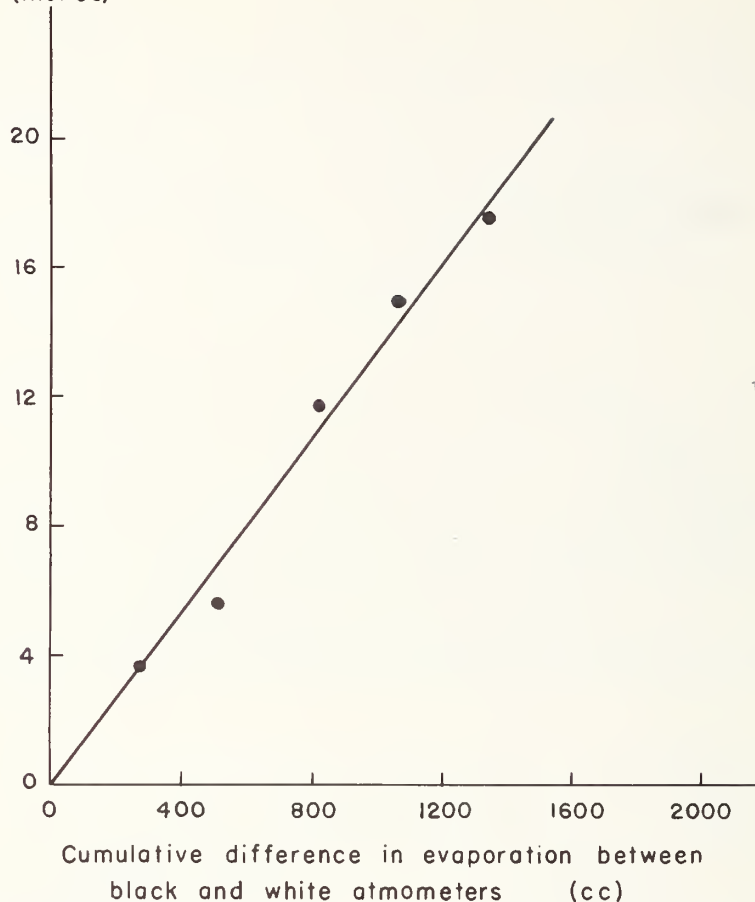
Figure 3. --Relationship between water use by tules and evaporation from atmometers at
Joice Island, Calif.

The evaporation studies are being carried on in cooperation with the Corps of Engineers, U. S. Army, as a part of their comprehensive study of the San Francisco Bay region.

California

SAND FILTER PROMOTES HIGH INFILTRATION INTO AQUIFERS

Leonard Schiff, Bakersfield. --Tests employing shafts, pits and trenches as methods to recharge ground water were reported in Quarterly Report No. 7. With these methods surface soil of low permeability is removed so that the water contacts material of high permeability. Greater depths of water on coarse material also help to recharge areas at a faster rate.

One of the problems is that the exposed aquifer material tends to filter out the fine, suspended material in a thin plane, thus rapidly decreasing its permeability. Research is underway to find a filter material which can be placed over the aquifer and which will filter out the fine material throughout a greater depth of the filter material.

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To find a filter material meeting these requirements, sixteen manometer-equipped infiltrometers were set up as shown in the accompanying photo. Filter materials of 1/4-inch diameter pea gravel, 1/8-inch pea gravel, and coarse sand (.8 to 1.6 mm in diameter) were tried.

The coarse sand filter 0.2 foot in depth maintained infiltration rates 2.5 times those of the 1/4 and 1/8 inch pea gravels. In fact, the pea gravels produced no higher infiltration rates than the aquifer material without a filter. Manometers show some loss in head in the coarse sand filter as compared with practically no loss in head in the 1/4 and 1/8 inch pea gravel filters.
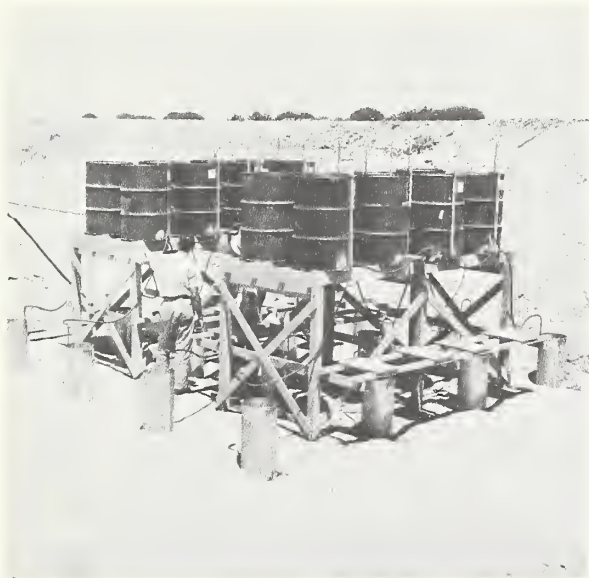
Infiltrometers equipped with manometers for studying
filter materials for use in ground water recharge, Bakers-
field, Calif.

California

INFILTRATION RATES INCREASED BY CHEMICALS IN WATER

Eldred S. Bliss and Curtis E. Johnson, Bakersfield. --Long term infiltration tests (still under way) with two good irrigation waters, one from Kern River and one from a well, show that significant differences occur in the infiltration rates of the two waters. An infiltrometer experiment was run using three additives in the river water to investigate the infiltration rate differences.

The following treatments were arranged in a latin square and replicated five times:
1.   Well water - untreated. Total salt concentration - 10.3 me/l, sodium percentage - 40, pH - 7.7.
2.   Kern River water - untreated. Total salt concentration - 1.1 me/l, sodium percentage - 40, pH - 7.7.
3.   Kern River water + 6.75 me/l gypsum, pH - 7.6.
4.   Kern River Water + 6.75 me/l ferric sulfate, pH - 2.9.
5.   Kern River Water + 2.50 me/l H_2SO_4, pH - 2.9.

Results of the test for the first 55 days are summarized in the accompanying drawing. The microbial population found in the surface soil of one infiltrometer of each treatment on the 46th day of the test is tabulated in the accompanying table. Also shown in this table is the relative algae content in all infiltrometers.

Infiltration rate (feet/day)
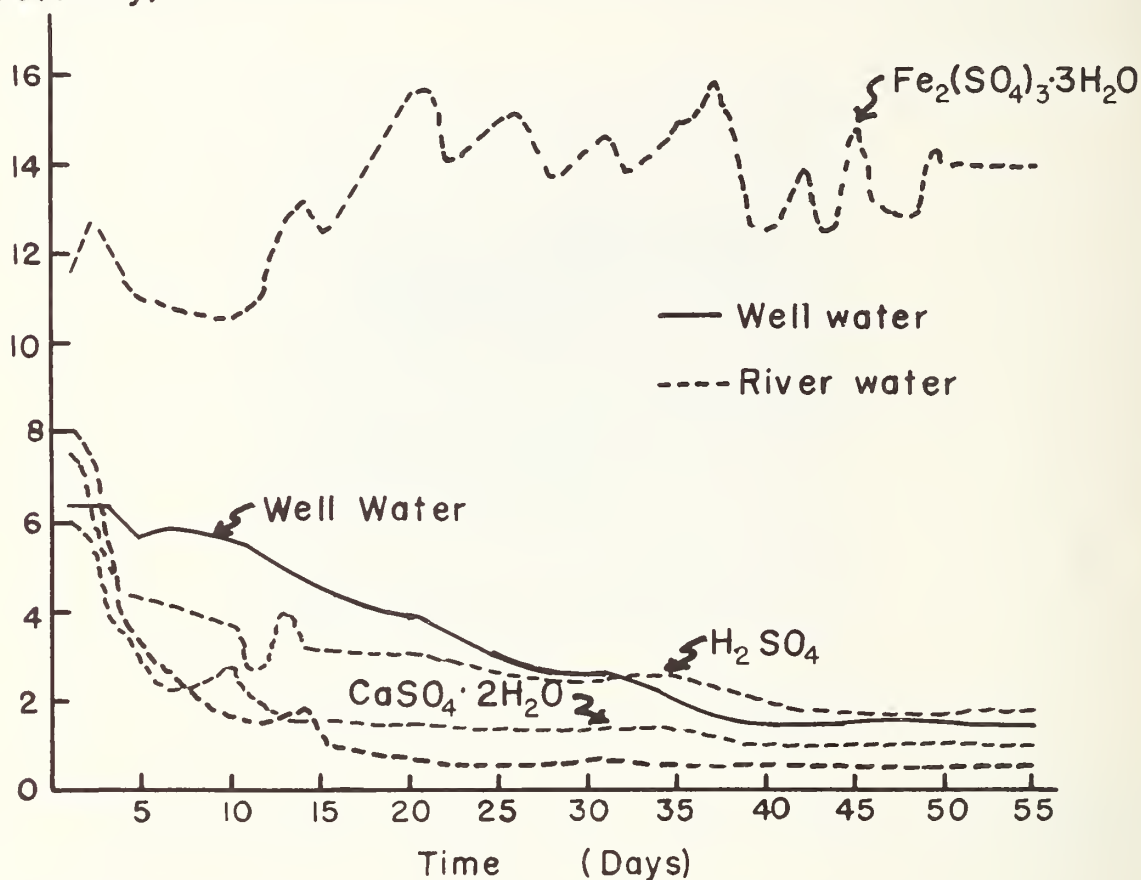
Average infiltration rates with infiltrometers of waters having indicated treatments, Bakersfield, Calif.

Microorganisms in the 0-3 inch depth of soil and relative amount of algae in the water after 46 days, Bakersfield, Calif.

Treatment	Soil microorganisms per gram	Algae
	Millions	
Well water (Untreated).........	45	Abundant
Kern River Water (Untreated)...	31	Abundant
Kern River Water + Gypsum......	15	Abundant
Kern River Water + Sulfuric Acid........................	0.2	None
Kern River Water + Ferric Sulfate.....................	1.4	None

It is apparent that ferric sulphate in the water had a pronounced accelerating effect on infiltration rates under the conditions of this experiment. This treatment as well as the sulfuric acid treatment greatly reduced the microbial population and completely prevented the growth of algae.

The concentration of ferric sulfate used was equivalent to approximately 1400 pounds per acre foot of water, an application rate obviously impractical for use on a large scale. The results obtained are encouraging, however, and the tests are being expanded and continued. The infiltration rates secured through the use of ferric sulfate are far in excess of those found in previous water-spreading experiments.

<u>Washington</u>

WATER INTAKE RATE INCREASES WITH ALFALFA AGE

Stephen J. Mech, Prosser. --That age of alfalfa is the biggest single factor affecting intake of irrigation water was reported in Quarterly Report No. 8. The greatest difference was found between the first and second cutting years.

How rapidly the increase between the first and second cutting year takes place is shown in the accompanying figure and table. These data were obtained from the first cutting
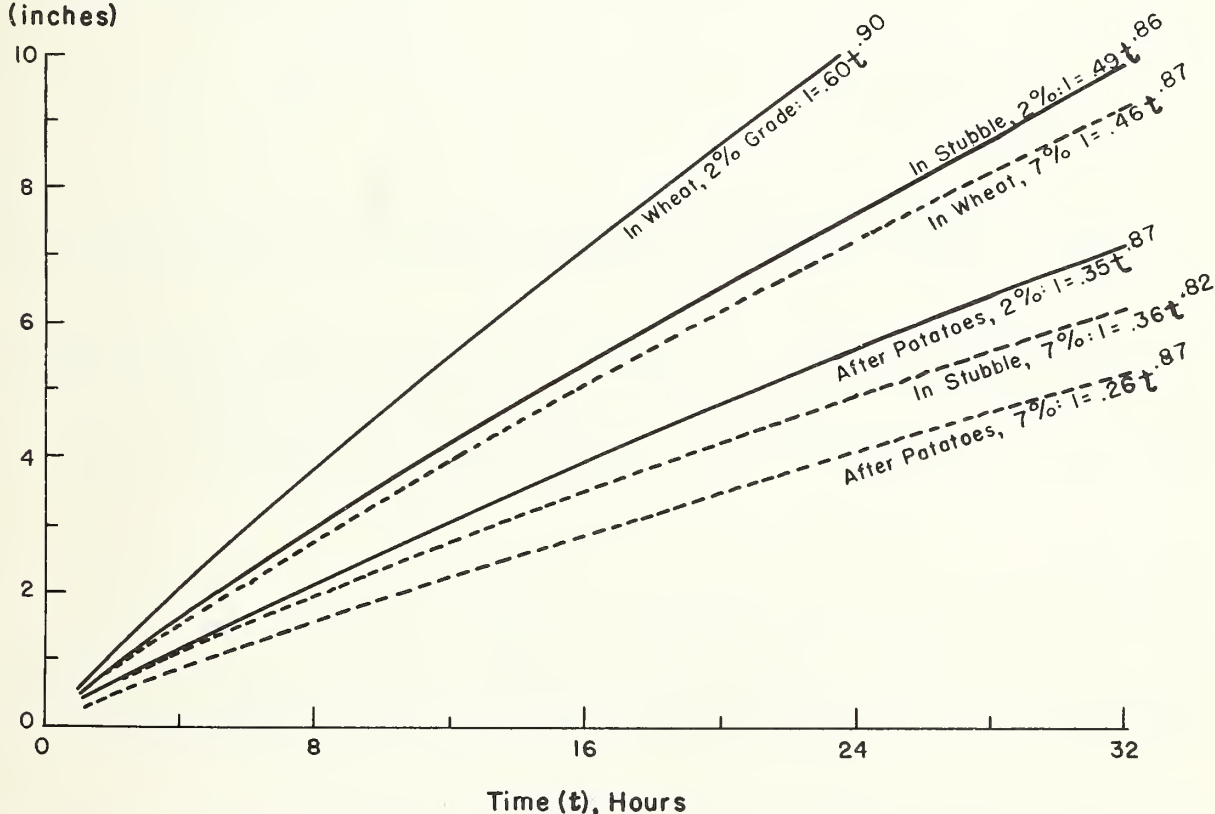
Cumulative water intake curves for the first full cutting year of alfalfa seeded the previous year in wheat, in wheat stubble, and after potato harvest. Curves are for "medium" soil moisture and "q" stream size on Sagemoor fine sandy loam, Prosser, Wash., 1956.

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year of alfalfa grown on Sagemoor fine sandy loam which was seeded the previous year. It was seeded on the following dates and seedbed conditions:

1. Seeded in wheat on March 20. Wheat cut for hay.
2. Seeded in wheat stubble on August 9.
3. Seeded on September 7 following potatoes.

No comparison was made of the influence of seedbed conditions. The differences are attributed to the influence of alfalfa itself rather than any residual effect of differences in seedbed condition.

Water intake characteristics during first alfalfa cutting year, Prosser, Wash., 1956

Seeding date	2% Furrow Grade			7% Furrow Grade		
	Intake equation*	For 6-inch Irrigation		Intake equation*	For 6-inch Irrigation	
		Required duration	Average intake per hour		Required duration	Average intake per hour
		Hours	*Inches*		*Hours*	*Inches*
March 20......	$.54t^{0.10}$	13	.46	$.40t^{0.13}$	19	.32
August 9......	$.42t^{0.14}$	18	.33	$.30t^{0.18}$	31	.19
Sept. 7.......	$.30t^{0.13}$	26	.23	$.22t^{0.13}$	37	.16

*$i = at^b$

Though these intake data cover what is nominally the first cutting year, actually there was considerable difference in the age of the alfalfa. That seeded in March was a year old at the beginning of the test year while that seeded in September was barely past the seedling stage.

An evaluation of irrigation characteristics based on integrated intake rate equations shows that, on a 7% furrow grade, it required a 19-hour irrigation to add 6 inches of water to the alfalfa seeded in March and 37 hours to that seeded in September. A comparison of the rate curves for the same two seeding dates shows that the intake rate equations ($i = .40t^{0.13}$ and $i = .22t^{0.13}$) had the same change with time ($t^{0.13}$) but varied considerable in their "a" value, 0.40 and 0.22 respectively.

California

SOIL SOLUTION CHANGE WITH IRRIGATION PREDICTED

R. H. Brooks, J. O. Goertzen, and C. A. Bower, Riverside.--A theory originally developed for describing the process of cation-exchange during passage of a salt solution through an exchanger column such as used for water softening has been successfully applied to the changes in salinity brought about by irrigation of soil in a field plot.

A fallow plot of Pachappa sandy loam protected from evaporation was irrigated with water having a total cation concentration of 30 meq./l. of which 27.5 meq./l. were sodium and 2.5 meq./l. were calcium plus magnesium. Porous cups buried at various depths in the soil were used to sample the soil solution periodically. Samples of soil solution were obtained by applying vacuum through Neoprene rubber tubes connected to each cup.

The experimental values obtained for composition of soil solution after application of various depths of water agreed closely with the values predicted from the theory as shown in the figure below. In the figure, the ordinate values express the ratio of the sodium to the total cation concentration of the soil solution. The solid lines give compositions predicted from the theory, while the points represent the experimental data. Curves are shown for five soil depths (Z).

Further work is in progress to determine the validity of the theory under cropping conditions. Successful application of the theory will permit prediction of the sodium status of soils at various depths as the soil is leached with different amounts of a specified irrigation water.
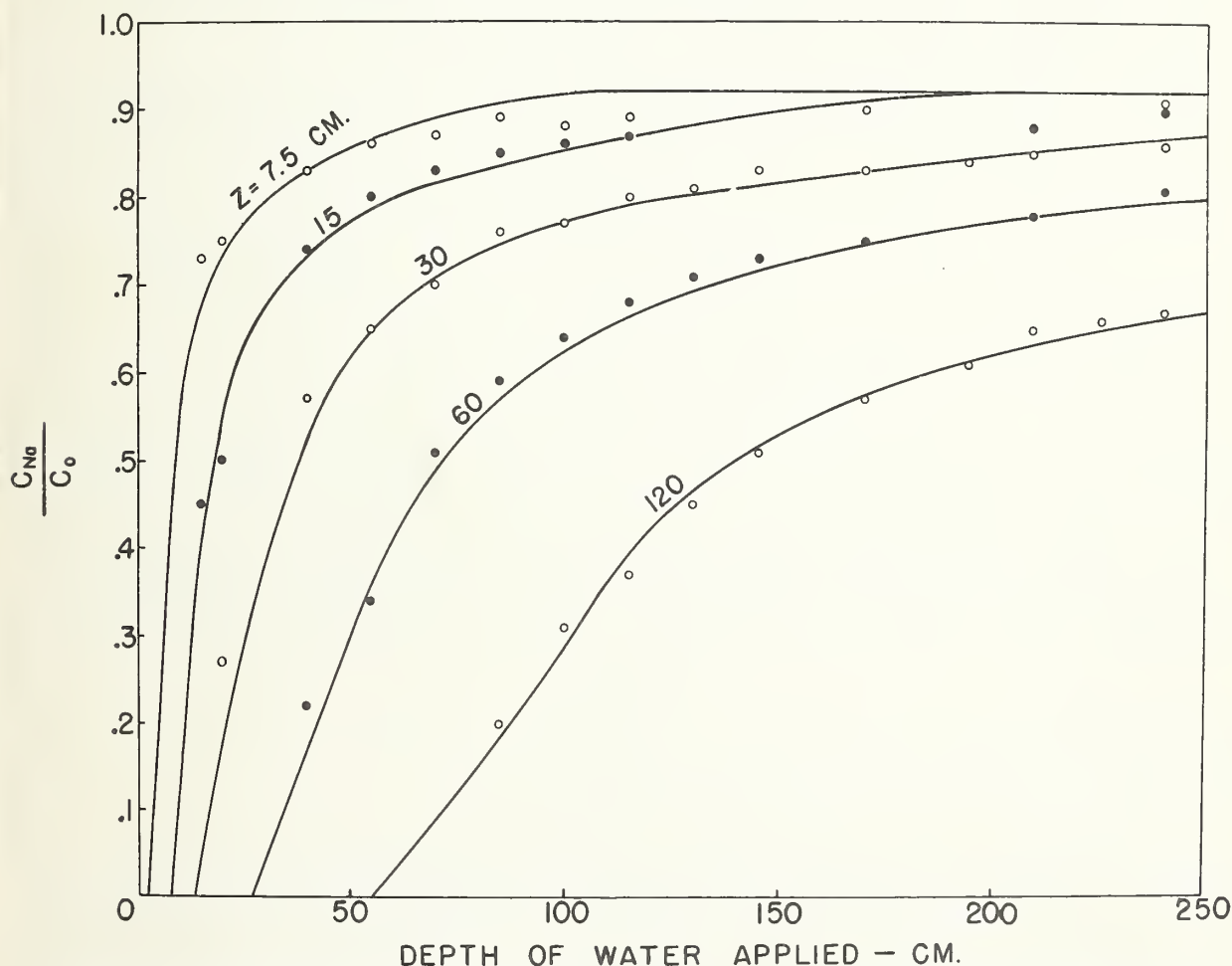
A comparison of theoretical and experimental compositions of soil solution at various soil depths as a function of depth of water applied. Numbers on the curves (Z) indicate the depth in soil at which sample was taken.

Florida

OVERHEAD IRRIGATION INCREASES POTATO YIELDS

Henry Ozaki and J. C. Stephens, Fort Lauderdale. --Irrigation and fertilizer investigations with Sebago potatoes at Plantation Field Laboratory, indicate that supplemental overhead irrigation improves the yield and quality of the crop even where the soils are irrigated by the sub-surface seepage method.

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Water levels in these sandy soils were held at a depth of approximately 2 feet which has been indicated by other studies as the best depth for seepage irrigation. However, the potatoes were grown during a season with little rainfall and the supplemental sprinkler irrigation appears to have been of value in preventing an excessive concentration of salts in the upper root zone and in carrying the plant nutrients down so they were available for the crop.

The potatoes were grown on 12 plots in a split block design with three replications. At planting time all plots were fertilized with 5-10-5 fertilizer at the rate of 1,000 pounds per acre. Two additional sidedressings of N and K_2O were applied. Six plots received 25 pounds N and 25 pounds K_2O per acre at each sidedressing and the other 6 plots received 75 pounds N and 75 pounds K_2O per acre at each sidedressing. After each side-dressing one-half of the plots were sprinkled with from 1/2 inch to 1-1/8 inch water (3 of each sidedress treatment). The other 6 plots were not sprinkled.

A brief summary of the results is given in the table below.

Effect of supplemental overhead irrigation on quality and yield of Sebago potatoes, Ft. Lauderdale, Fla.

| Fertilizer treatment | Yield of potatoes per acre | | | | | |
| | Sub-irrigation only | | | Sub-irrigation plus overhead irrigation | | |
Total N & K_2O per acre	U.S. Fancy	U.S. #1	Total	U.S. Fancy	U.S. #1	Total
Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
100 each...............	10,060	2,360	12,420	14,580	2,260	16,830
200 each...............	10,370	1,950	12,310	15,390	2,260	17,650

It is likely that without subsurface irrigation the differences in yield would have been greater. On the other hand, with normal rainfall these differences would probably be smaller.

DRAINAGE

Louisiana

PRECISION GRADING ADAPTED TO CANE LAND

I. L. Saveson, Z. F. Lund, Baton Rouge. --Adapting the precision grading and shallow "V" ditch of the Louisiana cotton section to cane land on the Margaret plantation was done at a cost of approximately $69.00 per acre. Machine efficiency was low, however, since cuts and fills were especially light. The smoothing operation after grading increased the bulk density of the fields to about that of the cut area. There was an indication that thorough ripping of the soil after grading and leveling is desirable since the smoothing operation led to considerable compaction.

This work was done on a Mhoon Silt Loam soil with very flat slopes, the majority having .05 foot fall per 100 feet. The smoothing operation called for elimination of several laterals and all quarter drains. In the new layout, row drainage was directed into lateral ditches which were shallow enough to be crossed with farm machinery, mowed for weed control, and cleaned with a small-bladed implement. Ditch spacing was increased from 200 to 600 feet.

Cuts and fills as shown in Table 1 were especially light and also yards of earth moved per hour were exceedingly low, indicating that it is not an advantage to design the jobs for light yardage. Where haul distances are approximately the same, machine time per acre has been about the same, regardless.

Table 1.--Earth moving and time required in forming and smoothing cane land, Margaret Plantation, Port Allen, La.*

Plot		Earth moved			Time	
Number	Size	Per plot	Per acre	Per hour	Per plot	Per acre
		Grading (Forming)				
	Acres	Cubic yards	Cubic yards	Cubic yards	Hours	Hours
1..............	14.12	2,422	171.53	52	47	3.33
2..............	11.59	1,881	162.29	} 48.6	41	} 3.34
3..............	2.98	551	184.90		9	
Total........	28.69	4,854	169.18	-----------	97	3.38
		Leveling (Smoothing)				
Total........	28.69	-----------	----------	-----------	66	2.30
		Cutting ditches				
Total........	28.69	-----------	----------	-----------	15	.52
		Cutting headlands				
Total........	28.69	-----------	----------	-----------	7	.24
Complete operation total						6.45

* Average cut: .193 Ft.   Average fill: .167 Ft.
  Maximum cut: .5 Ft.   Maximum fill: .4 Ft.
  Minimum cut: .05 Ft.   Minimum fill: .05 Ft.
  Average haul distance Plot 1: 500 Ft., Plots 2 & 3: 700 Ft.
  Average cost per acre: $69

Table 2.--Effect of grading and smoothing on soil physical properties, Plot 1, Margaret Plantation, Port Allen, La.

Area	Depth	Bulk density		Porosity	
		After grading	After smoothing	After grading	After smoothing
	Inches	Gms/Cm^3	Gms/Cm^3	Percent	Percent
Fill..............	1 - 4	1.28	1.44	50.7	44.6
	7 - 10	1.47	1.56	43.5	40.0
	13 - 16	1.48		43.3	
Cut..............	1 - 4	1.42	1.52	45.2	41.6
	7 - 10	1.53	1.57	41.3	39.4
	13 - 16	1.49		42.7	

Table 3.--Effect of grading and smoothing on soil physical properties, Plot 2, Margaret Plantation, Port Allen, La.

Area	Depth	Bulk density		Porosity	
		Before grading	After smoothing	Before grading	After smoothing
Fill.................	Inches 1 - 4 7 - 10 13 - 16	Gms/Cm^3 1.41 1.47 1.41	Gms/Cm^3 1.50 1.50	Percent 45.7 43.5 45.9	Percent 42.5 42.5

Although there is insufficient data to be conclusive, the data clearly indicate the need for thoroughly ripping up the soil after grading. The smoothing operation led to considerable compaction, even though the soil had a relatively high bulk density. Permeability was negligible in all cases, except in a fill area before the smoothing operation. It dropped from .25 inches per hour with a 3-inch head to .02 inches during the smoothing operation. Percentage of large pores was not affected except that there appeared to be some destruction of large pores in the 1- to 4-inch depth in the fill areas.

Minnesota

90-DEGREE JUNCTION SATISFACTORY FOR TILE DRAINS

P. W. Manson, F. W. Blaisdell and C. A. Donnelly, St. Anthony Falls.--The junction energy loss for a 90-degree drain tile junction angle is insignificant from a practical standpoint according to laboratory studies conducted over the last two years. This means that the 90-degree junction will give as satisfactory results for agricultural drainage systems as the more commonly recommended 45-degree junction.

The laboratory study was set up to determine junction energy losses when the lateral has the following area-ratios to the main: 1:1, 1:2, 1:4, 1:7, and 1:16. The entry angles were 15, 30, 45, 60, 75, 90, 105, 120, 135, 150 and 160 degrees. The velocity of the flow in the lateral and the main ranged from 2 to 15 feet per second. The pipes were flowing full at all times.

Since the last progress report, No. 4, May, 1955, the data for 1:2 and the 1:4 ratios have been completed for all entry angles and velocities above noted. It will require another year to complete the investigations for the 1:7 and 1:16 ratios. The equipment has already been built for conducting the research for these ratios.

Colorado

FIELD EVALUATION UNDERWAY OF EXISTING TILE DRAINAGE SYSTEMS

A. R. Robinson, Fort Collins.--The general objective of this project is to provide drainage engineers with dependable criteria upon which to base the design of new drains on irrigated lands in Colorado. The general objective is amplified by the following specific objectives:

1. To determine if a relationship exists between drain discharge and physical features of the drain, drainage characteristics of the soil and water supply in order to predict water yields to be expected from new drains.

2. To check by field data the theoretically derived relationship between soil drainage properties, shape of the water table draw down and boundary conditions.

Tile drain systems have been selected on ten farms in northeastern Colorado for study the first season. These ten systems are of the interceptor type and were chosen to best represent the most prevalent drainage problems. The discharge from the drains is being collected by means of automatic recorders attached to small measuring flumes. Ground water data are being assembled from cased observation holes installed in lines normal to the drain lines. Hydraulic conductivity measurements employing the auger hole method are being made. The physical features and soils data are being assembled from Soil Conservation Service records.

EROSION AND RUNOFF CONTROL

New York

SOIL AND WATER LOSSES AFFECTED BY CROPPING PRACTICES

G. R. Free, Ithaca. --Soil losses under corn on a 17% slope on Honeoye silt loam were only 0. 05 ton per acre during a severe storm August 30, 1956 as compared with 6. 93 tons from a similar storm on September 9, 1941.

This marked difference in erosion appears to be associated primarily with previous cropping practices. The plots showing no soil loss had been in an alfalfa-grass sod for seven years prior to the corn crop whereas the high soil losses occurred during the third year of continuous corn without a cover crop.

Detailed data for the two storms are given in the table below:

Date	Amount	Duration	Max. intensity for time periods - inches per hour			
			5 min.	15 min.	30 min.	60 min.
	Inches	*Hours*				
8/30/56	3.3	4	5.0	3.6	2.6	1.7
9/9/41	2.0	2 3/4	5.0	3.4	2.0	1.8

Runoff from the storm in 1956 was 0. 25 inch as compared with 0. 74 inch in 1941. Rainfall immediately prior to the two storms was similar.

Georgia

HURRICANE RAINFALL ABSORBED UNDER GOOD CONSERVATION MANAGEMENT

A. P. Barnett, Watkinsville. --The effects of good soil conservation management on infiltration and water holding for future crop use was demonstrated by the absorption of nearly 6. 29 inches of rain accompanying hurricane Flossie at the Watkinsville station September 22-24, 1956. Good conservation management in this case was grass sods or row crops immediately following grass sod. With continuous cotton there was two inches less absorption in addition to a soil loss of 2/3 tons per acre.

The rainfall occurred over a period of 38 hours. Intensities were low throughout the storm with a maximum five minute rate of 1. 44 inches per hour and 0. 75 inches per hour for 65 minutes. The soil was extremely dry prior to the rain. Antecedent rainfall was 1. 27 inches in August and 0. 48 inches in September.

Measurements on runoff plots showed that water and soil losses from different cropping treatments on land Class III were:

Cropping treatment	Runoff	Soil loss per acre
	Inches	*Tons*
Cotton continuously....................	2.02	0.68
Cotton 2nd year after grass sod.......	1.89	0
Corn 1st year after grass sod.........	0.74	0
Fescue grass sod 1st year.............	0.13	0
Fescue grass sod 2nd year.............	0.01	0

Kansas

AEOLIAN DUST HAS MUCH THE SAME COMPOSITION AS LOESS

W. S. Chepil, Manhattan. --Analyses of dust transported at various heights during dust storms in Kansas and Colorado indicated that the dust has about the same mechanical composition as loessal soils common to the region. The largest sand particles in the dust had a diameter of about 0.25 mm.

This study confirms a somewhat controversial hypothesis that loess is aeolian in origin.

The removal of large quantities of dust from loessal soils was characterized by non-selective removal, that is, by complete disintegration and removal of the surface soil. Removal from sandy soils was selective. Much of the silt and clay and some of the very fine sand was removed, leaving the other sands behind. The residual sands usually piled up into dunes.

Considerable variation existed in the composition of suspended dust depending on the composition of eroded soil, year of measurement, and distance and height of transport. This variation was no greater than the variation in the composition of loess.

Dust transported at any height or deposited anywhere by a single windstorm was characterized by one predominant or peak diameter of the particles and by arms on each side of the peak falling off each at its own uniform rate. The peak diameter was not the same for all samples of dust, but varied with wind velocity and height and distance of travel.

SOIL FERTILITY

Oregon

NITROGEN STIMULATES WHEAT YIELDS

Albert S. Hunter, Corvallis. --While yield data have not yet been completely analyzed, it appears that significant wheat yield increases have been obtained with nitrogen fertilizer on 39 of the 42 farms of the 1955-56 fertilizer experiments in the Columbia Basin Counties of Oregon. On the remaining three farms, the effect of nitrogen was not significant.

In eight cases fall application appeared to be superior to spring application of nitrogen, and in six cases, spring application was superior. In 27 cases, the yield differences between fall and spring applications were too small to be significant.

Wheat yield increases due to the application of nitrogen were as follows:

Lower rainfall area, 39 farms

Rate of N per acre	Increase per acre	
	Fall N	Spring N
Pounds	Bushels	Bushels
20	5.2	4.7
40	9.3	8.4
60	12.1	11.1
80	13.1	11.5
100	14.3	13.6

Higher rainfall area, 3 farms

Rates of N per acre	Increase per acre	
	Fall N	Spring N
Pounds	Bushels	Bushels
30	11.2	10.3
60	17.7	18.2
90	21.4	23.0
120	18.4	24.2
150	19.1	24.0

Twenty-four of the thirty-three 1953-54 winter wheat fertilizer experimental sites were examined in the late spring of 1956. On 14 of the 24 farms examined, the growing crops showed visual evidence of fairly large residual effects of one or more rates of the nitrogen applied to the previous wheat crop. The wheat on two of these sites was subsequently harvested for yield records.

The magnitude of the residual effects of nitrogen fertilizer on wheat appears to be inversely related to the effectiveness of the nitrogen in increasing the yield of the crop to which it is applied. The effects were considerably less on plots fertilized with nitrogen in the fall than on those where it was applied in the spring. The former plots were subjected to leaching from rains of one additional winter season.

Oregon

ASPARAGUS RESPONDS TO NITROGEN FERTILIZER

T. P. Davidson, C. A. Larson, Hermiston. --The results of fertilizer experiments with asparagus at the Umatilla Branch Experiment Station, indicate that nitrogen fertilizer is not needed on asparagus plantings until the second year after planting. Fertilizer applied at this time would be available to build up reserves in the crowns for the first full season's cutting. Phosphorus and potassium have yet to show any beneficial effect. Two hundred pounds of nitrogen did not give a significantly higher yield than one hundred pounds, but both rates gave significantly higher yields than where no nitrogen was added.

Texas

NITROGEN INCREASES WATER USE ON IRRIGATED WHEAT

Marvin E. Jensen, Amarillo. --In an irrigated winter wheat experiment conducted in 1955-56 the water use increased with increasing increments of nitrogen fertilizer. The efficiency of water in producing wheat also increased with the addition of nitrogen.

A response to nitrogen is characterized by more vigorous plant growth, especially in early spring. The additional vegetative growth probably accounts for the increased water use with nitrogen. The fertilized plots had considerably more vegetative growth, that is, more tillers and height. There was no practical difference in maturity as all plots on each moisture level were harvested on the same day.

The following table summarizes the yields obtained in 1956:

Effect of soil moisture and nitrogen on the yield of irrigated winter wheat, Amarillo Experiment Station, Texas, 1956

Fertilizer per acre			Yield of wheat grain per acre						
			Moisture treatment						
No.	Nitrogen	P_2O_5	M-1	M-2	M-3	M-4	M-5	M-6	Average
	Pounds	Pounds	Bushels	Bushels	Bushels	Bushels	Bushels	Bushels	Bushels
F-1........	80	0	17.4	26.6	40.1	46.2	43.0	40.0	35.5
F-2........	0	30	16.9	22.3	29.3	33.6	30.5	32.0	27.4
F-3........	40	30	17.6	25.2	33.7	40.1	38.8	36.3	31.9
F-4........	80	30	18.1	26.2	41.5	45.9	44.2	38.9	35.8
F-5........	120	30	17.5	28.1	42.9	52.4	50.1	42.7	39.0
F-6........	80	60	18.9	25.5	38.0	45.3	45.0	41.3	35.7
Average...			17.7	25.6	37.6	43.9	41.9	38.5	34.2

	L.S.D.	
	5%	1%
Moisture means	2.7	3.7
Fertilizer means	1.3	1.8

Water-use measurements were made by taking soil samples before and after each irrigation and at regular intervals between irrigations. The irrigation treatments are described in Quarterly Report No. 9.

The accompanying charts show the water-use and the bushels of wheat per inch of water obtained with each of the treatments.
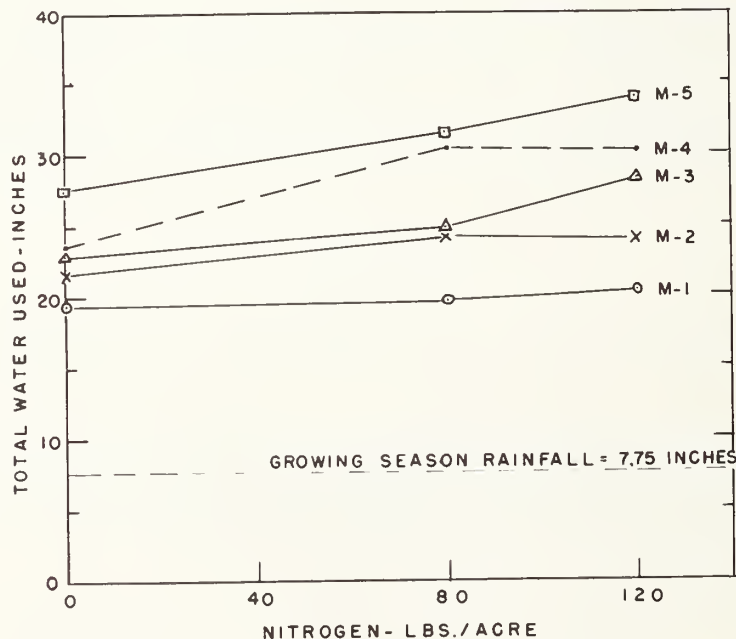
EFFECT OF SOIL MOISTURE AND NITROGEN ON
TOTAL WATER USED BY IRRIGATED WINTER WHEAT.
AMARILLO EXPERIMENT STATION, 1956
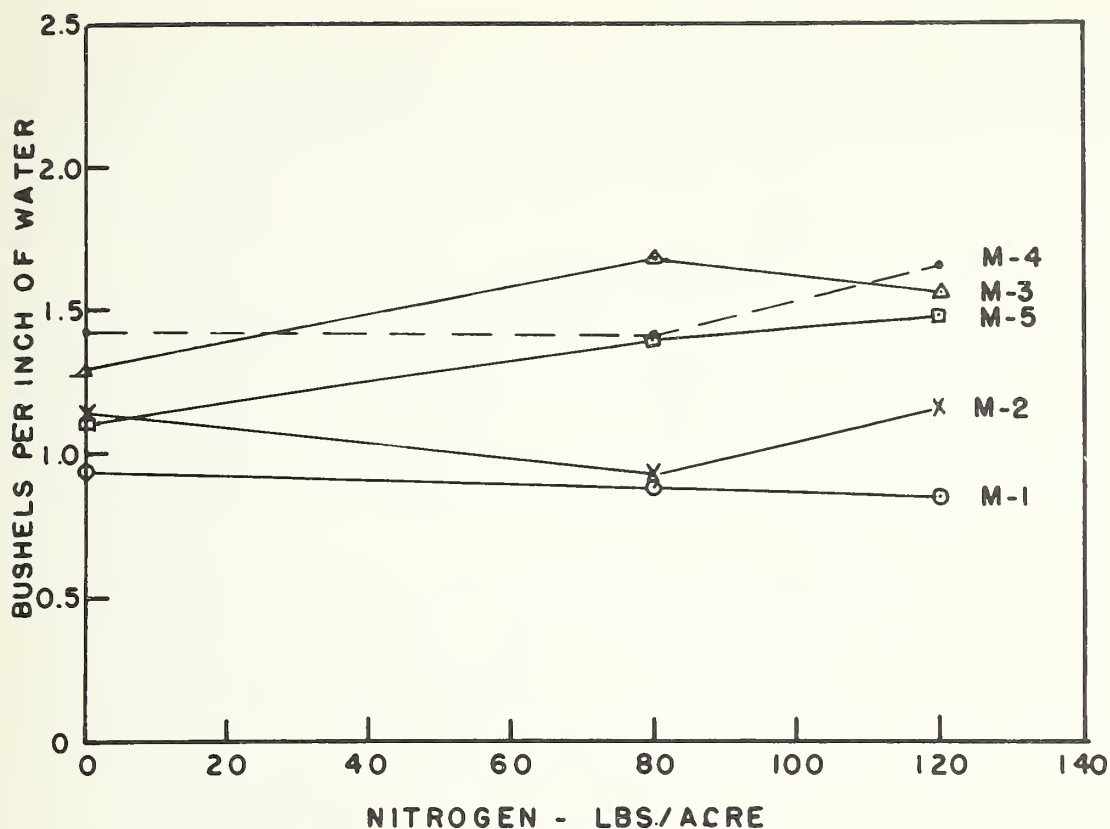
EFFICIENCY OF PRODUCING WINTER WHEAT PER INCH
OF WATER AS AFFECTED BY SOIL MOISTURE
AND NITROGEN. AMARILLO EXPERIMENT STATION, 1956.

Arizona

ARIZONA RANGE SHOWS RESPONSE TO RESIDUAL NITROGEN

Joel E. Fletcher, Tombstone, Arizona. --A preliminary test was conducted last year on Walnut Gulch Watershed to determine whether nitrogen fertilizer application in connection with watershed management practices would result in modified water yield and sediment production. The nitrogen application reported as 135 pounds per acre in Quarterly Report No. 6 but finally computed to be 120 pounds per acre, was broadcast following the first four inches of summer rain in 1955. No effective rain has fallen on the Rothrock grama plots this year, so yields were not taken again on them. Yields from the three-awn grama plots for 1955 and 1956 were as follows:

	Yield per acre	
	1955	1956
	Pounds	*Pounds*
Control..................	508	143
Fertilized..............	3,777	280

The big decrease in yield in 1956 was due to the rainfall deficiency.

Additional plots in brush and in open grassland were fertilized with 100 pounds of nitrogen per acre in 1956. These showed a 57 percent increase of grass in the brush area and a 17 percent increase of grass in open grassland resulting from nitrogen. These increases will just a little more than pay for the fertilizer.

North Dakota and South Dakota

NITROGEN INCREASES ABSORPTION OF BANDED PHOSPHORUS

D. L. Grunes, H. R. Haise, and L. O. Fine, Mandan and Brookings. --Using radio-active phosphorus, field experiments were conducted in North and South Dakota to determine the effect of added nitrogen on the relative availability of soil and fertilizer phosphorus to sugar beets and potatoes. The addition of ammonium nitrate with a band of concentrated superphosphate increased the percentage of the plant phosphorus absorbed from the fertilizer for both crops. The data are summarized in the accompanying table. Similar effects were reported in Quarterly Report No. 5 for a study with barley in a growth chamber.

Yields of sugar beets and potatoes, and percentage of the total plant phosphorus absorbed from the fertilizer, as influenced by applied nitrogen

Soil type and location	Crop	Fertilizer per acre N	Fertilizer per acre P	Plant P absorbed from fertilizer — Youngest matured leaves				Roots	Yield per acre
		Pounds	Pounds	Percent 8/9	Percent 9/10	Percent 9/24	Percent 10/9	Percent 10/9	Tons
Williams loam, North Dakota	Sugar beets	0	22	57	52	44	39	46	6.5
		100	22	70	60	63	48	57	7.5
Beotia silt loam, South Dakota	Sugar beets	0	17	7/1 23	7/15 19	7/30 18	8/12 12		21
		80	17	27	36	34	22		23
				Petioles and leaflets				Tubers	
				8/9		9/10		10/1	Bushels
Williams loam, North Dakota	Potatoes	0	13	10		6		8	336
		100	13	40		20		24	472

In a field experiment with sugar beets on Gardena loam, the percentage of the total phosphorus absorbed from the fertilizer was highly correlated with plant growth. Relatively more phosphorus was absorbed from the fertilizer for the larger yields obtained following the addition of nitrogen.

It is felt that the following causes are related to the magnitude of increase in percentage of the plant phosphorus absorbed from phosphorus fertilizer bands following the addition of nitrogen:

(a) Effect of nitrogen additions on amount of growth response, and on amount of total phosphorus absorbed.

(b) Decrease in pH following the addition of residually acid nitrogen fertilizers.

(c) Increase in root growth in the vicinity of the phosphorus band following the addition of nitrogen fertilizers.

For all experiments the percentage of the plant phosphorus absorbed from the fertilizer tended to decrease later in the season.

New Mexico

PHOSPHORUS APPLIED IN 1951 AFFECTS SORGHUM IN 1955

Ross W. Leamer, State College. --Phosphorus applied to alfalfa on a phosphorus deficient soil affects not only alfalfa yields and composition, but also affects yields and composition of sorghum grown following four years of alfalfa. This is demonstrated by results of a rotation experiment started in 1951 at Tucumcari, New Mexico.

Phosphorus was applied at rates of 0, 60, 120, 240, and 480 pounds P_2O_5 per acre to newly seeded alfalfa in the spring of 1951 on Springer fine sandy loam on the North-eastern Substation. No fertilizer was applied to the alfalfa after 1951. Three cuttings of alfalfa hay were harvested in 1951 and five cuttings in 1952, 1953, and 1954. The phosphorus caused differences in alfalfa yields in every cutting except the first two in 1951. The phosphorus content of the hay was also affected by the fertilizer.

The alfalfa was plowed down and sorghum planted in 1955. Nitrogen at a rate of 120 pounds of N per acre was added to half of each original plot when the sorghum was planted in 1955. The yield and composition of the 1955 sorghum grain and stover was determined. The factors affected by the two fertilizations are shown below.

Sorghum factor	Affected by:	
	1951 P_2O_5	1955 N
Yield of grain..........	Yes	No
Weight of stover........	Yes	No
N content of grain......	No	Yes
N content of stover	Yes	Yes
P content of grain	Yes	No
P content of stover	Yes	No

This shows that all factors measured on the 1955 sorghum, except nitrogen content of grain, were affected by the phosphorus applied to alfalfa in 1951. On the other hand, the nitrogen applied to sorghum following four years of alfalfa affected only the nitrogen content of the grain and the stover.

The values of the various factors are given in the following table:

Yield and composition of sorghum following four years of alfalfa fertilized in 1951, Tumcumcari, N. Mex. 1955

Year and fertilizer per acre		Sorghum yield per acre*		Nitrogen content**		Phosphorus content**	
1951 P_2O_5	1955 N	Grain	Stover	Grain	Stover	Grain	Stover
Pounds	Pounds	Pounds	Pounds	Percent	Percent	Percent	Percent
0	0	2,820	4,000	1.47	.58	.148	.054
0	120	3,110	4,060	1.58	.72	.155	.041
60	0	3,320	3,690	1.48	.59	.155	.049
60	120	2,990	4,060	1.52	.70	.141	.043
120	0	3,990	4,000	1.46	.66	.165	.051
120	120	3,730	4,320	1.59	.77	.159	.054
240	0	4,580	4,430	1.48	.69	.166	.054
240	120	4,630	5,060	1.51	.79	.176	.054
480	0	6,130	5,800	1.37	.81	.254	.100
480	120	6,400	5,160	1.55	.83	.254	.072

*Average of four replicates.
**Average of duplicate determinations of four replicates

Washington

SPECIAL PLACEMENT OF ZINC FERTILIZER IS EFFECTIVE ON HOPS

Louis C. Boawn, Prosser. --Zinc deficient hop plants in the Yakima Valley have responded slowly to zinc fertilizers disced into the surface soil. It may be that most of the zinc is immobilized near the soil surface and does not enter the feeding zone of the plant.

In a placement test, zinc fertilizers were placed in a trench 2 feet long and 10 inches deep about 1 foot on each side of plants in a hop yard near Toppenish in the spring of 1955.

No effect of the treatments on plant growth could be seen in either 1955 or 1956. Plant material samples consisting of the terminal four internodes of sidearms half way from the ground to the crosswire were taken to determine the extent of zinc utilization. A substantial increase in the zinc content of sidearms resulted when either zinc sulfate or a Zn-EDTA chelate was applied in this manner. Zinc utilization from the Zn-EDTA was greater than from the sulfate form in both years of the test. The content of zinc in untreated plants, probably resulting from earlier zinc fertilizer applications, was high enough to explain the absence of zinc-deficiency symptoms or lack of response to the treatments. Analysis data are summarized in the accompanying table.

The method of zinc fertilizer placement described would probably be commercially feasible with machine-made trenches. About one-half the application rate of 32 grams of zinc per plant as used in this experiment would be a reasonable application rate for the grower to use.

Zinc content of hop sidearms as affected by soil treatments,
Golding Farms, Toppenish, Wash., 1955-56

Treatment	Zinc content	
	1955 sampling	1956 sampling
	p.p.m	p.p.m
None.....................	21.2	30.3
Zn Chelate................	29.5	43.4
Zn Chelate + Mn Chelate....	28.5	42.7
ZnSO$_4$....................	25.8	36.9
L.S.D. .05	6.8	5.2

Alabama

ROCK PHOSPHATE AVAILABILITY INFLUENCED BY KIND OF LIME

G. L. Bennett, L. E. Ensminger, and R. W. Pearson, Auburn. --The kind of liming
material used can have a tremendous effect upon the availability of rock phosphate to
plants. Results from laboratory and greenhouse studies supporting the Southern Regional
Rock Phosphate Project show that application of dolomite to a Lloyd clay loam resulted
in sharply depressed availability of rock phosphate as measured by plant growth and phos-
phorus uptake. This was true whether the lime was applied three months before planting
(in order to give time for reaction with soil before addition of the phosphate) or at plant-
ing. When soil was prelimed with silicate (blast furnace) slag on the other hand, there
was a definite increase in availability of the rock phosphate. When both materials were
added at the same time, however, the slag did depress availability of the rock phosphate
slightly. The yield data shown in the table illustrate this differential effect of liming
material on Vaiden clay.

The slag did not raise the soil pH as high as did an equivalent amount of dolomite.
This fact may account in part for the difference in availability of the rock phosphate, but
there are obviously other factors involved, as can be shown by a comparison of treat-
ments that resulted in the same final pH. Thus, 1,000 pounds of dolomite and 2,000 pounds
of slag both produced a pH of 4.9. Yet where the lime was applied three months before
the phosphate, the slag-treated pots produced nearly twice as much plant growth as did
the dolomite treated pots. Since there was no difference in yield of the dolomite and slag
treatments where no phosphorus was added, the differential effect must be on the availa-
bility of the added rock phosphate.

Influence of rate and kind of lime on rock phosphate availability as measured by yield of
Ladino clover on Vaiden clay, Auburn, Ala. 1956

Lime		Soil pH	P$_2$O$_5$ per acre		Yield per pot	
Source	Applied per acre		Rock phosphate	Superphos- phate	Lime at planting	Lime 3 months before planting
	Pounds		Pounds	Pounds	Grams	Grams
Dolomite	0	4.5	80	0	8.45	8.43
	1,000	4.9	80	0	6.81	7.89
	2,000	5.4	80	0	5.16	6.20
	4,000	5.9	80	0	3.69	4.71
Calcium silicate slag	0	4.5	80	0	8.45	8.43
	1,000	4.7	80	0	7.70	13.02
	2,000	4.9	80	0	7.26	13.67
	4,000	5.0	80	0	5.94	13.27
Dolomite	1,000	4.9	0	80	10.70	9.13
	2,000	5.4	0	80	10.62	11.02
	4,000	5.9	0	80	11.16	11.64

SOIL STRUCTURE

Pennsylvania

HIGH DENSITY PREVENTS ROOT PENETRATION

W. V. Chandler, University Park. --Sudangrass roots were unable to penetrate soils of the Hublersburg, Sherley and Hagerstown series when the bulk density exceeded 1.70 grams per cubic centimeter. These results were secured with a new technique developed to measure the critical bulk density for plant root growth.

A three-by-three inch undisturbed core is collected with the Uhland core sampler. Cloth membranes are placed over each end of the core in its ring. An empty Uhland ring is secured over the top of the core by means of a wide rubber band. A fertile soil mixture is placed in this ring. Seeds of the test crop are planted in the soil mixture. Sufficient water is added to the surface of the soil mixture to moisten it to about three-fourths field capacity.

Figure 1. --Sudangrass in soil mixture above undisturbed core of soil for critical bulk density studies.

Generally, in about 10 to 14 days after planting the seed will have germinated and the roots will have penetrated the core if physical conditions are favorable. The core is then examined for root penetration and, after the roots have been studied, the soil is dried and the bulk density of the core is calculated.

Figure 1 shows a sample shortly after germination of sudangrass seed. Figure 2 shows some enlarged root tips of sudangrass which occurred quite often when the roots reached cores of bulk density 1.70 or higher. The critical densities for different crops and on a wider range of soils is being investigated.

Figure 2. --Sudangrass roots which have grown through a good soil mixture and into an undisturbed soil core of bulk density 1.75 grams per cubic centimeter.

SOILS HIGHEST IN SILT STORE MOST AVAILABLE MOISTURE

Vernon C. Jamison, Columbia.--That soils highest in silt content can store the most available moisture was revealed by the analyses of fifty-seven composite samples from 12 soil profiles in Missouri.

Profile samples from 12 locations were analyzed for soil moisture release at different suction levels from 0 to 15 atmospheres and estimates made of the available moisture storage capacities. Each of the 57 composite samples from the 12 profiles were taken from a separate soil layer or horizon. The 12 profiles sampled were: five on Putnam silt loam (claypan), McCredie, Mo; one on Weldon silt loam (claypan), Midway, Mo.; and six on Sharon silt loam (river alluvium), Elsberry, Mo. In addition to available moisture storage capacity, these samples were analyzed for mechanical composition (sand, silt and clay content). The relationships between the quantities of sand, silt or clay and the available moisture storage capacities were calculated. The results are show in the table.

Effect of soil texture on the available moisture storage capacity of selected Missouri soils, 1956

Soil fraction (separate)	Correlation coefficient*	Effect on available moisture storage capacity
Sand (> .05 mm.)..........................	- 0.32	Decreases
Silt (.05 - .002 mm.).....................	+ 0.79	Increases
Clay (< .002 mm.)........................	- 0.60	Decreases
Silt/clay ratio..........................	+ 0.72	Increases
Coarse Silt (.05 - .02 mm.)..............	+ 0.77	Increases
Fine silt (.02 - .002 mm.)...............	+ 0.44	Increases
Coarse Clay (.002 - .001 mm.)............	- 0.56	Decreases
Fine Clay (< .001 mm.)...................	- 0.50	Decreases

*Values numerically higher than 0.34 are significant at the 1% level of probability. Those above 0.26 are significant at the 5% level.

It is clear that for this group of soils those highest in silt are generally highest in available moisture storage capacities. Also high clay content reduces rather than increases the available moisture storage capacity. This is reasonable since the effective pore size in soil separates is usually about one-fifth to one-tenth of the particle size. The effective pore sizes in the suction force range of plant moisture availability would be from about .003 to .0002 mm. and would most likely be associated with particles in the silt range (.05 to .002 mm.). In soils low in silt content the coarse clay may contribute to storage. Sand is too coarse to retain much stored water. Clay holds much of its moisture in an unavailable state. Also clay particles fit in and fill spaces between silt particles where water could otherwise be stored.

Texas

SHRINKAGE CURVES HELP EXPLAIN BLACKLAND SOIL BEHAVIOR

R. M. Smith, Temple.--In soils work it is often customary to refer to bulk density and porosity as definite soil characteristics. However, with high-shrinking clays like those in the Texas Blacklands, it is necessary to consider moisture content whenever soil volume and porosity are involved. Moreover, since soil moisture is continually changing, it is important to visualize total soil volume, porosity and bulk density on a variable moisture basis.

The two shrinkage curves in Figure 1 apply to a fixed quantity of solid soil particles. The 45 degree diagonal is the line that total soil volume would follow if the soil system consisted entirely of solids and liquid. At any moisture content the vertical distance between the 100 cc. (cubic centimeter) base line and the diagonal corresponds to the volume of water per 100 cc. of solids; and the vertical distance of any curve above the diagonal represents the volume of air.

Two distinctly different soil structural conditions are represented. The top curve applies to lumps or clods of porous, natural surface soil from lightly-grazed native grass pasture. The lower curve is for re-formed lumps of the same soil after it was thoroughly puddled and mixed in the laboratory until practically all aggregation was destroyed.

At oven dryness the soil from the grass sod contained 70 cc. of total porosity per 100 cc. of solid, whereas the puddled soil contained only 33 cc. However, the total porosity of the puddled soil when wet and swollen was 122 cc., or much more than the 70 cc. porosity of the grass sod soil when dry and shrunken. This illustrates that swelling must be considered in comparisons of soil structure. When both samples were at or near their maximum moisture holding capacities, the porosities were similar: 122 cc. for the puddled soil versus 128 cc. for the unpuddled soil. The big difference was in air space. The puddled soil contained only 2 cc. of air space whereas the grass sod samples contained 48 cc. Moisture contents, of course, were different, being 120 cc. for puddled soil and 80 cc. for the unpuddled soil. Swelling obviously was greater for the puddled soil, corresponding more or less to the differences in moisture.

These porosity and moisture values are expressed in cc. per 100 cc. of solid in order to avoid the confusion of having a variable volume as a base. The approach is similar to the classic method of depicting soil shrinkage, as used by Haines. (Haines, W. B. 1923. The volume-changes associated with variations of water content in soil. Jour. Agr. Sci. 13: 296-310.) Percent moisture at any point on a shrinkage curve may be obtained by dividing soil specific gravity into the cc. of moisture indicated. Bulk density at any moisture content is determined by multiplying soil specific gravity by 100, and dividing by the cc. of total soil volume.

Further illustrations of soil porosity relationships are provided in Figure 2. At 14 percent moisture the Houston Black clay did not pack, by the "Proctor" method, to as low a porosity or as high a density as the same soil at 20 percent moisture. When packed at 14 percent moisture, the soil contained 66 cc. of total porosity whereas when packed at 20 percent moisture the porosity after packing was 58 cc. Wetter soil, packed at 28 percent moisture, had 78 cc. of total porosity, or more than either of the drier samples. The reason, as may be seen in Figure 2, is that the wet soil could not be compressed further without losing a part of its water. Only a small volume of trapped air remained when the soil was packed, either at 20 or at 28 percent moisture. On the other hand, the soil packed at 14 percent moisture contained 28 cc. of air space after packing.

When water was eliminated by allowing the soils to dry and shrink, as shown in Figure 2, the bulk densities of the samples packed moist (20 percent) and wet (28 percent) became similar, whereas dry density for the soil packed at 14 percent moisture was considerably less. It is evident that puddling or mechanical compaction may be effective in eliminating air space from moist or wet Blackland soils, but maximum density is achieved only through shrinkage.

Although many Blackland soil volume and pore space relationships may be clarified by means of shrinkage curves of soil lumps, it should be remembered that alternate shrinkage and swelling quickly causes marked structural and porosity changes even in the laboratory. And in the field, regardless of plant effects or details of soil structure, such factors as gross shrinkage cracks between soil blocks or lumps may dominate infiltration rates and other important soil properties.

CC Of Total Soil Volume

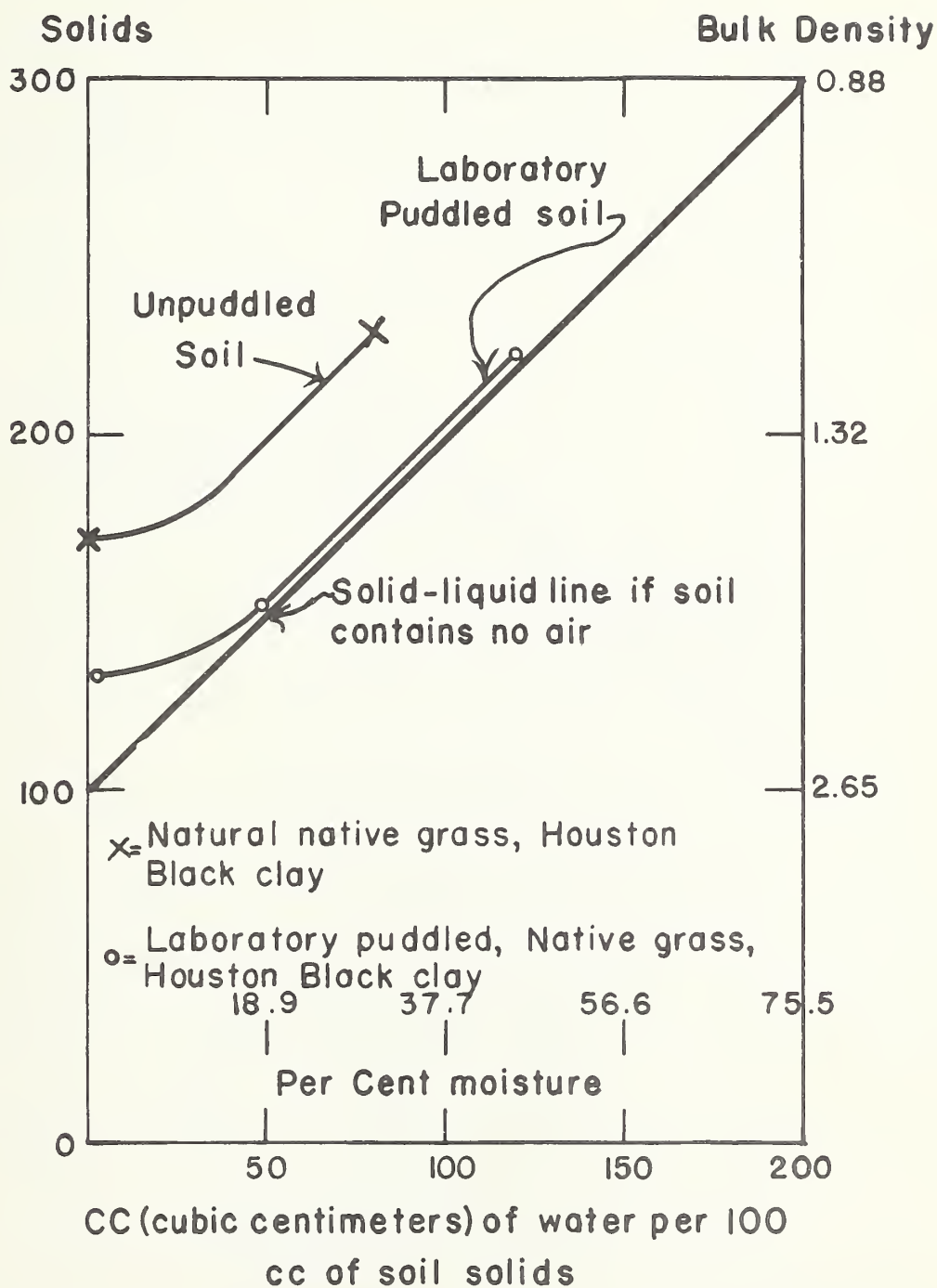per 100 CC of Soil

Figure 1. --Shrinkage curves for lumps of Houston Black clay surface soil from native grass pasture, Temple, Texas.
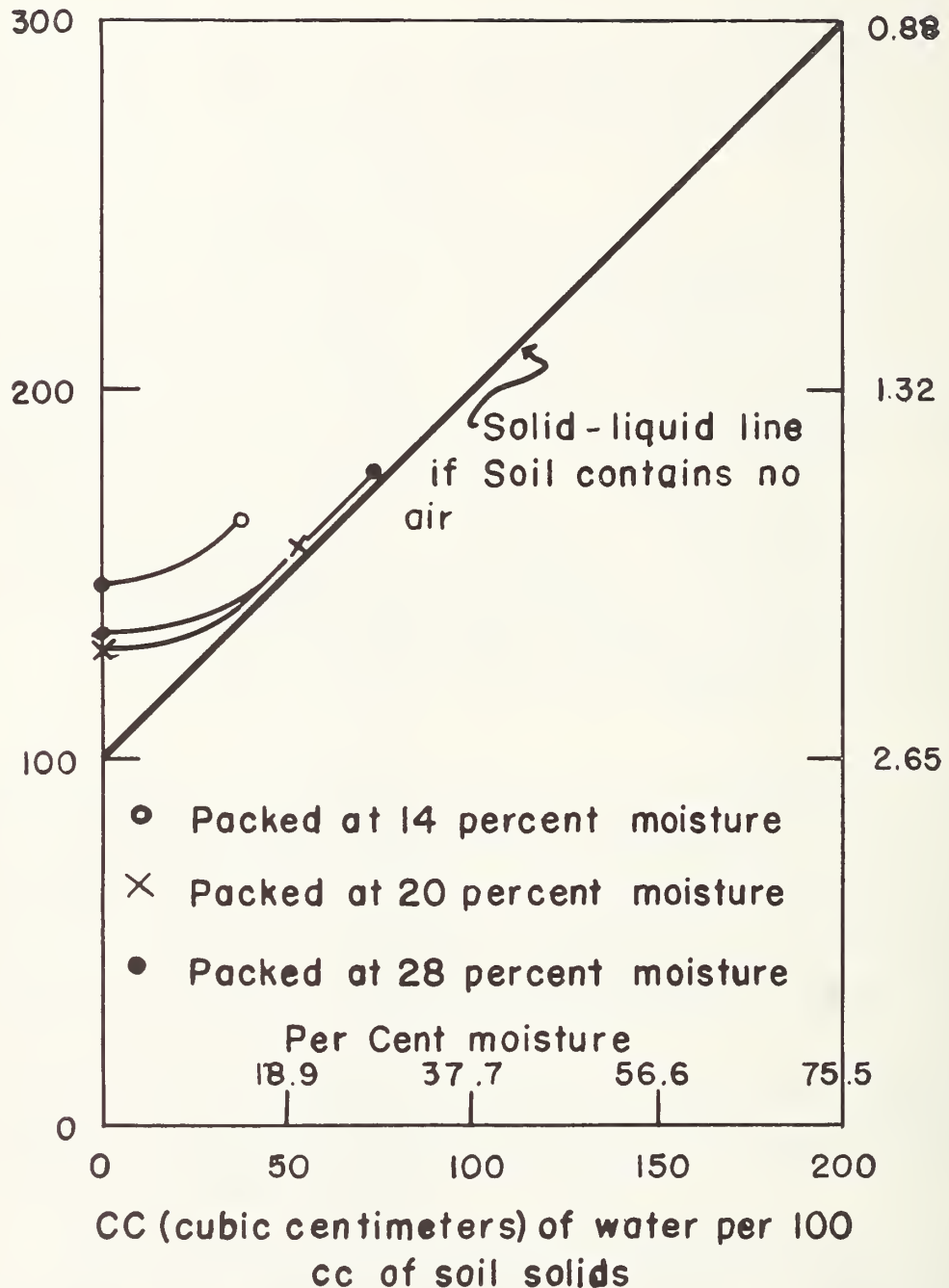
Figure 2.-- Shrinkage curves for "Proctor" packed Houston Black clay cultivated surface soil, Temple, Texas.

CROPPING SYSTEMS

<u>Texas</u>

WINTER COVER CROPS DEPRESS COTTON YIELDS

R. M. Smith, R. C. Henderson and R. J. Hervey, Temple. --In a field experiment with four replications, cotton yield on Austin clay soil was 225 pounds of seed cotton per acre following cotton with no winter cover crop and 203 pounds following a winter cover crop of Austrian winter peas planted on the sides of the beds. The peas were killed with subsurface sweeps on April 5, four weeks before cotton planting, without disturbance of the beds. Samples taken April 23 showed 1.3 inches less moisture in the surface 3 feet of soil where peas were grown than where no winter cover crop was used.

Seed cotton yields in cropping system plots with 4 replications, on Houston Black clay, also showed somewhat lower yields for cotton following several different winter cover crops grown on the sides of the beds, as follows:

	Seed cotton per acre
	Pounds
Continuous cotton (no winter cover)...................	348
Continuous cotton (peas winter cover).................	289
Continuous cotton (oats winter cover)	311
Continuous cotton (oats winter cover + N)	303
Continuous cotton (Madrid sweetclover winter cover) ...	281

Cotton root rot was not a serious factor in any of these plots in 1956. The worst root rot incidence was about 2 percent. The primary factor causing yield reduction following winter cover crops is believed to have been moisture. The cotton after winter covers showed severe drought stress symptoms sooner than where no winter cover was grown. During dry years a 1.3 inch reduction in stored moisture probably is enough to reduce cotton yields appreciably. Similar results with winter green manures have been obtained at Temple for the past several years.

RESIDUE MANAGEMENT

<u>California</u>

MAINTENANCE OF RESIDUES DIFFICULT ON DRY-FARM GRAINLAND

Maurice Donnelly, Riverside. --An early objective in the experimental work on dry-farm grainland in the Pacific Southwest was to test soil management practices which would permit the maintenance of cover of plant residue on the soil surface during the critical erosion period in the fall of the year, just before or after planting. In the form of barley straw, desirable quantity is 2,500 to 3,000 pounds per acre. There is seldom this much material present on the surface at the critical period.

The plant residue cover remaining after using different methods of preparing grain stubble for summer-fallow is shown below. It should be noted that somewhat less cover than the amounts shown would be present at planting time, as these measurements were made in mid-summer and some additional attrition takes place by late fall.

The plant residue cover remaining after tillage for summer fallow under controlled degrees of soil inversion is summarized below. These quantities were made possible by the employment of a special tillage machine by which controlled degrees of soil inversion could be made with considerable precision. All measurements were on a specially selected site which had a uniform cover of straw and volunteer grain plants at the time of the first tillage.

Primary tillage[1]	Secondary tillages[2]	Cover per acre before tillage	Cover per acre after tillage	Cover after tillage
		Pounds	*Pounds*	*Percent*
3-blade V-sweep + light disk	Rodweeder + shovels	1,480	1,050	71
5-blade V-sweep	Rodweeder + shovels	1,820	1,010	56
Double disk	Rodweeder + shovels	1,940	810	42
Moldboard plow	Rodweeder + shovels	2,206	200	9
Single V-sweep	Single V- sweep	1,840	1,530	83

[1] Single operation.
[2] Two operations

Primary and secondary tillages[1]	Cover per acre before tillage	Cover per acre after tillage	Cover after tillage
	Pounds	*Pounds*	*Percent*
3-blade V-sweeps no inversion by disk	1,830	1,200	65
3-blade V-sweeps 1/3 inversion by disk	1,830	700	38
3-blade V-sweeps 2/3 inversion by disk	1,830	440	24
3-blade V-sweeps complete inversion by disk	1,830	160	9

[1] One primary and two secondary operations.

The effect of the number of blades, or sweep standards, on the quantity of plant residue remaining after subtillage with V-blade sweep machines is shown in the accompanying graph. All three machines covered a tillage width of about 8 feet. While there are differences in the shape of the V-blades and in the design of the standards, in general the differences shown in the graph are those which can be expected from the operation of these machines. The differences are largely due to burial of plant material by inversion alongside the standard that supports the blade.

residue at surface (%)

Number of sweep standards on tillage machine
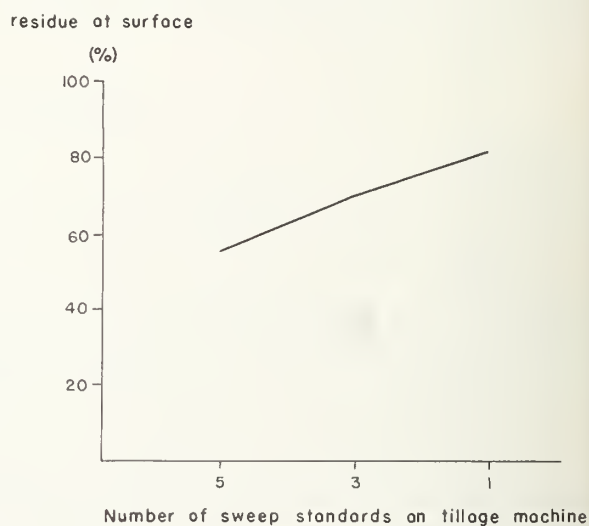
Plant residue remaining at surface after subtillage in relation to number of V-blade sweeps used in initial tillage, Riverside, Calif.

MULCHING INCREASES, NITROGEN DECREASES WHEAT YIELDS

F. L. Duley and R. E. Luebs, Lincoln. --In a rotation of sweet clover 2 years, oats, wheat, the 1956 wheat yields were as follows:

Tillage	Wheat yield per acre		
	Nitrogen	No Nitrogen	Mean
	Bushels	Bushels	Bushels
Plowed........................	21.0	26.5	23.8
Stubble mulch...................	26.5	27.7	27.1
Mean...........................	23.8	27.1	----------

L.S.D. @ 5% between N treatment means - 2.8 Bu/A.

The nitrogen was applied in 1955 at 40 pounds per acre. There was a tendency for the yield of plots receiving nitrogen in 1955 to be decreased more with plowing than with sub-tilling.

In a rotation of grass-alfalfa 3 years, corn, corn, oats, wheat, with 40 pounds of nitrogen per acre applied in 1955, the yields of wheat were:

Tillage	Wheat yield per acre		
	Nitrogen	No Nitrogen	Mean
	Bushels	Bushels	Bushels
Plowed........................	21.6	26.8	24.2
Subtilled......................	34.1	32.8	33.5
Mean..........................	27.9	29.8	----------

L.S.D. @ 5% between means N with same tillage treatment equals 3.7 Bu/A.

No significant difference between tillage means or nitrogen means.

These results tend to emphasize what may happen during dry years. Under low rainfall conditions stubble mulching tends to have an advantage over plowing. During years of higher rainfall and on the average, plowing has given slightly higher yields than has stubble mulching at Lincoln, Nebraska.

Also the effect of nitrogen fertilizer on wheat yields has usually been favorable. In 1956 the rainfall was about 32% below normal during spring months. This probably explains why the crop did not benefit from nitrogen applied the year before.

TILLAGE AND CULTURAL PRACTICES

FERTILIZER PLACEMENT IMPROVES YIELD UNDER MULCH

J. E. Moody, J. Nick Jones, J. H. Lillard, Blacksburg. --Results from mulch tillage studies at Blacksburg, Virginia, during the last three years indicate that placement of fertilizer may alleviate the tendency toward yield depression and nutrient tieup obtained with mulch tillage procedures. The double-cut plow principle of mulch tillage was compared with conventional turnplow tillage where several methods of fertilizer placements were used in the production of corn in a corn, small grain, and hay rotation.

In 1953, yields were higher from both tillage treatments where part of the fertilizer was placed in bands 2" to the side and 2" below the seed as compared to complete broadcast of the fertilizer. However, nutrient uptake was less under mulch tillage than with conventional tillage.

In 1954 and 1955, applications which included part of the fertilizer banded in the row as in 1953, part broadcast, and most of the nitrogen (70# - 80#) banded midway between the rows, gave yields and nutrient uptake from mulch tillage comparable to the highest obtained from conventional tillage. Conversely, where the row band or the between the row band placement was omitted, nutrient uptake and yields were depressed much greater under mulch than under conventional tillage procedures.

A description of the treatments and a summary of the results are given in the accompanying table.

Effect of fertilizer placement on grain yield and nutrient content of mature corn plants under mulch and clean tillage practices, Blacksburg, Va., 1953-55

N-P-K fertilizer per acre			Tillage[1]	Uptake of nutrients per plant[2]			Yield per acre
Banded 2" side 2" below seed	Broadcast	Between row band of N		N	P	K	
1953							
Pounds None	*Pounds* 100-100-100	*Pounds* None	Turnplow Mulch	*Grams* 3.86 3.39	*Grams* .48 .43	*Grams* 3.37 3.04	*Bushels* 80.5 82.2
30-30-30	70-70-70	None	Turnplow Mulch	4.34 4.03	.52 .49	4.06 3.37	86.7 87.3
1954							
10-20-20	20-80-80	70-6" depth	Turnplow Mulch	3.77 3.83	.50 .52	3.09 3.26	92.7 89.8
10-20-20	20-80-80	70-2" depth	Turnplow Mulch	3.79 3.62	.52 .51	3.10 3.00	92.6 93.8
None	30-100-100	70-2" depth	Turnplow Mulch	3.84 3.35	.53 .48	3.21 2.74	93.1 85.2
1955							
20-20-20	0-80-80	80-6" depth	Turnplow Mulch	3.45 3.48	.41 .37	3.26 3.02	78.5 79.7
20-20-20	80-80-80	None	Turnplow Mulch	2.94 2.86	.34 .35	3.13 2.82	64.1 50.8

[1] Tillage Treatment: Turnplow consisted of conventional turn plowing seven inches deep with two discings for final seedbed preparation. Mulch consisted of double cut plowing (inversion of top 3 inches and simultaneous subtillage of 3 to 7 inch layer) with two spring tooth harrowings or equivalent for final seedbed preparation.
[2] Includes all growth above ground.

SUCCESS WITH INTERSEEDINGS RELATED TO MOISTURE

W. E. Larson and W. O. Willis, Ames. --Success with interseedings of forages in wide spaced corn rows is influenced by width and direction as well as by moisture and temperature. Data obtained at Ames, Iowa indicate that forage stand establishment is largely related to the amount of soil moisture available to the young seedlings. Light intensity is also an important factor. Frequently soil moisture stress is too great for forage seedling establishment in normal 40-inch spaced rows. By widening the corn rows moisture stress is lessened at most locations between the rows. The row width best suited to a given situation will depend on the expected soil moisture supply. Thus 60-inch spaced rows may be best suited to more humid areas whereas 80-inch or even wider spaced rows may be desirable from a forage establishment viewpoint in drier areas.

SOIL DEPTH
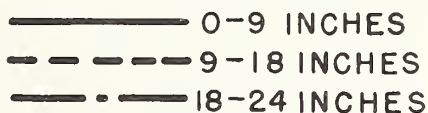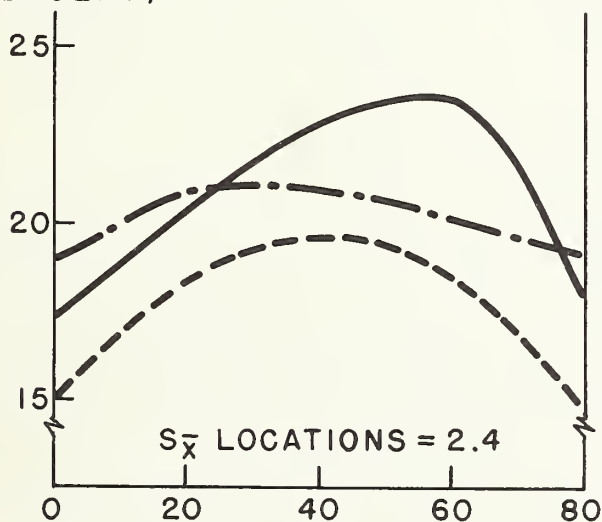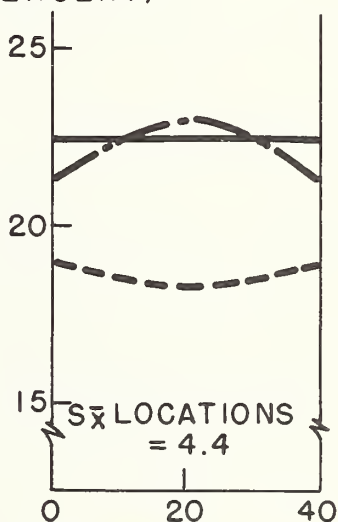
——————— 0-9 INCHES
— — — — —9-18 INCHES
—— · ——18-24 INCHES

Soil moisture distribution between 40- and 80-inch spaced corn rows, Seymour silt loam, Ames, Iowa, Aug. 30, 1954.

It appears that if a choice is possible corn should be planted in rows running north and south. North-south rows give a better distribution of light and the differences in soil temperature and moisture are minimized.

STUBBLE-MULCH FALLOW INCREASED WHEAT YIELDS IN 1956

Paul L. Brown, Hays. --Fallow by stubble-mulch tillage increased 1956 wheat yields over fallowing by plowing or onewaying. The increased yields are largely the result of increased moisture storage.

The fallow operations were started in early May, 1955, on wheatstubble land. The plowed fallow was plowed once, disked as the second operation and subsequently duck-footed only to control weeds. Oneway preparation consisted of onewaying as necessary to control weeds. Stubble-mulch tillage was performed with sweeps and a duckfoot cultivator as necessary to control weeds. Soil on the experimental site was Yocemento silty clay loam (tentative).

Prior to late September rains in 1955, the average depth of moist soil for the three methods of fallow was approximately 24 inches. Following the 7.63 inches of rain in September, the moisture depths were determined using a soil moisture probe. (See page 45, Progress in Soil and Water Conservation Research No. 7, February 1956). Soil moisture samples were taken on all plots on April 2, 1956. The fall soil moisture depths, the spring available soil moisture amounts and the 1956 wheat yields are shown in the following table:

Fallow preparation	Moisture depth 10-31-55	Available water to 6 foot depth 4-2-56	Wheat yields per acre
	Inches	*Inches*	*Bushels*
Plow..................	25.5	5.99	6.7
Stubble-mulch tillage	34.6	7.09	13.8
Oneway...............	25.1	5.29	9.1
L.S.D. 5%	4.7	1.41	1.2
Coefficient of variation: 11.3%		15.8%	8.3%

Texas

CHEMICAL WEED SPRAYS DEPRESS SORGHUM YIELDS

Allen F. Wiese and Jack J. Bond, Amarillo.--In the spring of 1955 a chemical fallow study was started on a dryland wheat-sorghum-fallow rotation at the Amarillo Experiment Station. Stubble mulch tillage was used as a check against (1) chemical weed control with one sweep operation for seedbed preparation, and (2) complete chemical control between crops. With each tillage practice crops were either planted with conventional planters which disturb crop residues or with surface planting equipment with a minimum of residue disturbance. Stubble mulch tillage was performed with 30-inch sweeps. Broadleaf weeds were chemically controlled with 1 pound of 2, 4-D ester per acre and grasses with 8 pounds of dalapon per acre. Just prior to sorghum planting, fair grass control was obtained with 2 pounds of aminotriazole per acre. Aminotriazole was used at this time because it does not have as much residual effect in the soil as does dalapon. Weed control in sorghum was accomplished with a sweep cultivator or normal cultivation plots and with 2, 4-D and dalapon on plots where weeds were chemically controlled.

In 1955, wheat was planted with a shovel drill and a pasture renovator drill. In 1955, sorghum was planted in 40-inch rows with a lister planter and with a surface planter. The available surface planting equipment for sorghum was not suitable in that it would not penetrate into untilled soil, and the pasture renovator drill disturbed too much crop residue. As a result, a new planting unit was constructed for this purpose which could be used for planting either winter wheat or sorghum. This unit cuts residues and makes a narrow slit in the soil with an 18-inch rolling coulter. The coulter is followed by a 3/4-inch width wedge-shaped furrow opener and a rubber press wheel which presses the seed into moist soil. In 1956, excellent stands of sorghum were obtained with this machine.

Wheat yields were not obtained in 1956 because of hail; however good stands of wheat were obtained on all tillage treatments.

Effect of tillage and weed control practices on sorghum yields, Amarillo, Texas, 1956

| | Treatment | | | Average grain yield per acre |
No.	Preplanting seedbed preparation	Planting method	Postplanting weed control	
				Pounds
1A	stubble mulch	lister	chemical	1,089
1B	stubble mulch	lister	cultivation	1,182
2A	stubble mulch	surface	chemical	1,152
2B	stubble mulch	surface	cultivation	1,242
3A	chemical weed control plus one tillage	lister	chemical	949*
3B	chemical weed control plus one tillage	lister	cultivation	1,217
4A	chemical weed control plus one tillage	surface	chemical	955*
4B	chemical weed control plus one tillage	surface	cultivation	1,240
5A	chemical weed control alone	lister	chemical	261**
5B	chemical weed control alone	lister	cultivation	728**
6A	chemical weed control alone	surface	chemical	576**
6B	chemical weed control alone	surface	cultivation	907*

 * Indicates significant decrease in yield at 5 percent level as compared to treatment No. 1B.
 **Indicates significant decrease in yield at 1 percent level as compared to treatment No. 1B.

Using stubble mulch tillage, lister planting, and sweep cultivation, (treatment 1B) as a basis for comparison, significant decreases in yield at the 5 percent level were obtained with treatments 3A, 4A, and 6B. Using the same treatment for comparison, significant decreases at the 1 percent level were obtained with treatments 5A, 5B, and 6A. These results indicate that chemical weed control is most effective when used as a preplanting weed control measure in conjunction with one tillage operation for seedbed preparation. This is illustrated by the average yield of 1,217 pounds per acre for treatment 3B and 1,240 pounds per acre for treatment 4B.

Visual observations of the plots indicated that weeds were not satisfactorily controlled in the sorghum with herbicides. In addition to the damage caused by the weeds, the 2, 4-D and dalapon used for weed control injured the sorghum. Additional research is being conducted in an attempt to find herbicides less injurious to sorghum, and new spraying equipment is being built which will give better spray placement than the sprayer previously used.

Wyoming

DEEP CHISELING UNDER STUDY ON WYOMING WHEATLAND

O. K. Barnes, Sheridan. --Among the several methods of summer fallow being studied at the Sheridan Station are three treatments on a silty clay loam soil on a steep hillside. These treatments are deep chiseling, moldboard plowing and subsurface tillage. The fields used are on contour strips on a 10 to 12 percent slope. This particular test

was started in the fall of 1954. Each treatment is replicated 3 times on plots approximately 7/10 acres each.

The soil was chiseled about 14 inches deep at 4-foot intervals soon after combining when the soil was very dry. The soil was loosened and heaved 2 feet on either side of the chisel point and large clods were thrown out along the chisel crease. Approximately two-thirds of the stubble was disturbed by the wheel tracks of the tractor and the clods which were thrown out. During the summer of 1955 this treatment was maintained weed free by two operations with a sweep implement with 30-inch sweeps and one disc operation in the late summer.

For the second treatment a 14-inch moldboard plow was used in the fall at a depth of six inches. This was left rough through the winter and kept weed free during the summer with the sweep implement and one disc operation in the late summer.

The subsurface tilled treatment was left with undisturbed stubble during the winter and was maintained weed free during the summer with the 30-inch sweeps for two operations and the disc for one operation in the late summer.

All treatments were seeded with winter wheat in the fall of 1955. The yields in 1956 from these treatments were as follows:

Chiseling 14" deep	29.4 bushels per acre
Plowing	27.2 bushels per acre
Subsurface tillage (30" sweeps)	22.1 bushels per acre

These treatments are being continued in this study with the addition of the Noble blade implement. Intensive studies are being made of water intake rates of these fallow treatments at different times of the season to further evaluate their effectiveness.

California

TESTS OF A NEW PLANTER-TILLER ENCOURAGING

Maurice Donnelly, Riverside. --One of the major obstacles to the wide-spread use of plant residues (stubble mulching) for the protection of dry-farm grainland in the Pacific Southwest has been the lack of a suitable planter.

Such a planter incorporating the following three features was given preliminary tests last season (1955-1956):

1. An opener to work beneath the stubble to a depth of about seven inches with a minimum of surface disturbance.

2. Two placement devices located in tandem behind the opener. Through the first may be delivered a solid or liquid fertilizer to a predetermined depth up to seven inches. The second downspout delivers the seed. Between the two is a device for covering the fertilizer to avoid contact with the seed.

3. A suitable rolling-type closure device to cover, smooth and level the seed row.

These tests demonstrated that basically the new planter-tiller meets the several specifications set up for its use, but revealed a need for further improvement in mechanical design.

Florida

HERBICIDAL TREATMENTS PROMISING FOR CONTROL OF ALLIGATOR WEED

J. C. Stephens, Ft. Lauderdale.--A new aquatic pest, alligator weed (Alternanthera philoxeroides), has appeared along arterial canal banks and become established in the organic soils of the Everglades.

The infestation appears to be quite recent, and an inter-agency group has combined efforts to combat it before it can become a serious threat to flow in the canal systems, or a menace to crop lands and to the plants that are of value to wildlife in the established fish and game refuges.

Among the agencies cooperating in the fight against alligator weed are Agricultural Research Service, Florida Agricultural Experiment Station, Florida Extension Service, Florida Game and Fresh Water Fish Commission, Central and Southern Florida Flood Control District, and the U. S. Fish and Wildlife Service.

A number of herbicidal treatment studies have been carried out both in the field and in the greenhouse. None of the treatments have proven 100 percent effective. Of the soil sterilants used, Telvar DW applied at 80 pounds per acre and Baron at 100 pounds per acre appear most effective. Their cost, however, limits their use in the fish and game refuge areas.

Of the hormone type sprays 2, 4-D appears to be most useful. However it does not appear to translocate between nodes of this plant and only a temporary top kill results. Since the plants in this area grow to a large extent in ponded water, with the mass of the weed under water, the 2, 4-D cannot reach enough of the plant to be very potent.

Tests made at Plantation Field Laboratory show that the efficacy of 2,4-D can be greatly increased under such growth conditions. This is accomplished by dissolving the 2, 4-D ester in a blended solvent which has a specific gravity of 1.004. An emulsifier is added and the formulation of 1 gallon of blended solvent (Aqua-Herb) to 1 gallon 2, 4-D ester is sprayed over the plants at the rate of 8 pounds acid equivalent per acre. The material is applied with a pressure sprayer (100 psi) in such a way that the herbicide homogenizes throughout the water so that the 2, 4-D is brought into contact with the entire mass of the weed except that part of the root system below ground surface.

Approximately 10 acres have been sprayed to date with very promising results.

Nebraska

FUMIGATION REDUCES NEMATODES IN SOILS

E. W. Hansen and T. M. McCalla, Lincoln.--Fumigants were applied to plowed and subtilled plots in September of 1955. These fumigants reduced the number of nematodes significantly when counts were made 17 days after treatment. The number of nematodes was reduced slightly more on the plowed plots than on the subtilled plots. Nematodes were not significantly reduced in the 0- to 1-inch depth of stubble-mulched plots, probably because of the organic matter layer at the surface. Seventy-two days after treatment there was some increase in number of nematodes on one of the fumigation treatments. Although nematode numbers were reduced, the yields of grain and straw were not affected by the fumigation. Yields of grain and straw were higher with stubble mulching than with plowing.

Effect of soil fumigation on nematode numbers and corn yield in a rotation of 3 years
bromegrass and alfalfa--corn--corn--oats--wheat, Lincoln, Neb., 1956

| Soil layer | Nematodes in 50 grams soil 17 days after fumigation | | | | | |
| | Plowed | | | Subtilled | | |
	W-40*	D-D**	Check	W-40*	D-D**	Check
Inches						
0 - 1..................	55	29	135	226	206	272
1 - 6..................	10	13	200	31	45	159
Mean..................	18	16	189	64	72	178
Wheat yield (Bu/acre)..	24	23	24	37	36⁻	35
Straw yield (Ton/acre).	0.85	0.80	0.90	1.3	1.3	1.2

*W-40 (41% Ethylene Dibromide by weight) supplied at the rate of 30 gallons per acre.
**D-D (Dichloropropene--Dichloropropane mixture) applied at the rate of 30 gallons per acre.

Kansas

RECOVERY OF GRAIN SORGHUM FROM DROUGHT UNSURE

Paul L. Brown, Hays. --Grain sorghum is a drought resistant crop. In spite of this fact, it has been noted that the crop frequently does not recover quickly from prolonged drought following substantial rainfall. A severe drought occurred in Kansas during the 1956 sorghum growing season. This provided an opportunity to learn something about the drought recovery capacity of grain sorghum.

The drop was planted under favorable surface soil moisture conditions. Subsoil moisture was deficient, however, and rainfall during June, July and August was nearly 5-1/2 inches below average. This deficiency produced severe moisture stress on most grain sorghum before heading time. Stress evidenced by leaf curling for increased periods of time each day as the season progressed, was so severe that the crop failed to head in many fields. As the stress continued, the leaves lost their dark green color and remained curled continuously. Growth stopped and the lower leaves desicated.

The crop would have headed during the first two weeks in August if growth had been normal. After the prolonged drought the question arose as to how quickly the drought-stricken grain sorghum would have recovered following a substantial rain.

On August 23, a plot of grain sorghum was selected that had failed to head due to drought. The lower leaves were dead and the upper leaves were light green in color and remain curled continuously. Using a portable 1/1000 acre dike, water was added to small plots of this grain sorghum. The amounts of water added were equivalent to 1, 2, 3, 4, 5, 6, and 7 inches. The above amounts wet the soil to a depth of 3.5, 8, 11.5, 17, 21, 23, and 26 inches, respectively.

The response to the added water was surprisingly slow. The plot receiving 1 inch of water showed practically no recovery. After 2 days, all plots except the plot receiving 1 inch of water showed signs of recovery. The first sign was uncurling of leaves followed by a darker green color. The effect of two inches of water lasted only one week at which time the plants returned to their former drought-stricken appearance. The effects of 3 inches of water lasted two weeks. The effect on color of 4 to 7 inches of water persisted.

Adding 1, 2, or 3 inches of water produced no heading. Four to 7 inches of water caused an occasional already-formed head to emerge from the boot and second growth heads formed on many of these plants. Second growth head development was somewhat proportional to the amount of water added above 3 inches. These heads began to emerge by September 15 but development was slow. They emerged too late to develop grain before frost.

From these observations, it appears that grain sorghum does not recover rapidly from severe drought stress. When the original head is damaged by drought at heading it will not emerge when soil moisture is restored. Sucker heads may develop but their development will frequently be too late to mature grain.

The drought resistance and drought recovery capacity of grain sorghum is not well understood. The popular concept that sorghums will stand drought stress for a prolonged period and recover sufficiently to produce grain appears to be in error. Research is needed to determine the drought resistance and drought recovery ability of both grain and forage sorghums.

Texas

KAFIR YIELDS DIRECTLY RELATED TO PRECIPITATION

James R. Coover and William C. Moldenhauer, Big Spring.--In general correlation between kafir grain yield and rainfall at the Big Spring Field Station on Amarillo fine sandy loam is quite high. A coefficient of multiple correlation as high as .83 was obtained for the relationship between grain yield and amounts of preseasonal and seasonal precipitation.

Grain yields on the long-term continuous kafir plots ranged from 0 to 46 bushels per acre, and stover yields ranged from 0 to 6,530 pounds per acre as shown in Table 1. After 1919 yields seem to level off from the extraordinarily high ones obtained during the first few years of production. When the yields after 1919 were considered, the coefficient of variation for grain yields was 52% and that for stover yields was 34%. Correlation between grain yields and stover yields was .46, which is highly significant but still quite low.

The coefficient of correlation between stover yield and annual precipitation was .60. Using preseasonal and seasonal rainfall data instead of annual data did not improve this relationship.

The frequency distribution of stover yields on Amarillo fine sandy loam, as shown by long-term records of the Big Spring Field Station, is given in Table 2.

Field observations indicate an over-winter loss in weight of kafir stover of 20% to 50%. The amount lost depends on many factors, but is influenced especially by the tillage required to produce a cloddy surface. It was found that about 750 pounds of stover at harvest time is needed to assure the minimum of 370 pounds during the critical erosion period the following spring.

Table 2 shows that failure to grow the 750 pounds per acre of stover required to control erosion on Amarillo fine sandy loam occurred twice in the 40 years of record at Big Spring. The grain crop, on the other hand, was a complete failure four times out of the 40 years of record.

Examination of the data in Table 1 shows that the stover yields of 0, 260 and 1,240 pounds per acre were grown in the years 1952, 1917, and 1918 respectively, when annual rainfall (September 1 to September 1) was 6, 7, and 8 inches respectively. The next lowest rainfall year was 1946 when 11 inches of rain fell. With 11 inches of rainfall or more, there seems to be very little relationship between rainfall and amount of stover produced. From these data it might be concluded that 8 inches is approximately the critical amount of rainfall for cover production on Amarillo fine sandy loam.

Table 1.--Annual precipitation and kafir grain and stover yield, on an Amarillo fine sandy
loam soil, Big Spring, Texas, 1915-1954

Year	Annual precipitation	Grain yield per acre	Stover yield per acre
	Inches	*Bushels*	*Pounds*
1915...........................	23	31	6,290
1916...........................	17	23	6,530
1917...........................	7	0	260
1918...........................	8	0	1,240
1919...........................	25	46	5,450
1920...........................	31	28	4,970
1921...........................	15	21	2,400
1922...........................	22	22	2,470
1923...........................	19	13	1,910
1924...........................	18	7	2,870
1925...........................	14	13	3,250
1926...........................	22	22	2,200
1927...........................	18	10	1,800
1928...........................	22	19	2,530
1929...........................	16	7	2,450
1930...........................	19	8	2,540
1931...........................	17	30	2,430
1932...........................	34	32	2,740
1933...........................	21	21	1,830
1934...........................	12	15	1,980
1935...........................	20	17	1,850
1936...........................	17	18	2,290
1937...........................	24	20	2,650
1938...........................	24	28	3,080
1939...........................	15	28	2,180
1940...........................	15	21	2,480
1941...........................	26	32	4,550
1942...........................	24	15	3,000
1943...........................	18	14	2,550
1944...........................	16	10	3,250
1945...........................	27	28	2,410
1946...........................	11	16	2,140
1947...........................	15	10	1,530
1948...........................	14	10	2,500
1949...........................	17	18	1,810
1950...........................	22	28	2,190
1951...........................	12	6	2,510
1952...........................	6	0	0
1953...........................	12	0	1,480
1954...........................	24	8	2,630
Mean...........................	18.5	17.4	2,630

Table 2.--Frequency distribution of stover yields of kafir on Amarillo fine sandy loam, Big Spring Field Station, Texas, 1915-54

Yield	Number of times occurring	Percentage of time occurring
Below 750 pounds/acre.............	2	5
750-1,500 pounds/acre.............	2	5
1,500-3,000 pounds/acre...........	27	68
Over 3,000 pounds/acre............	9	22
Total......................	40	100

At Seminole, Texas, 80 miles northwest of Big Spring, annual rainfall of 8 inches or less occurred twice in 32 years of record from 1923-1955 (except for 1927 when no record was kept). Two more years occurred when it is doubtful that planting could or would have been done because of lack of planting moisture at any time during the growing season. This means that in 4 years of the 32, no cover was grown on these soils, and emergency tillage was out of the question because of lack of moisture. Unless cover remained from the previous year and was retained during the entire year of the crop failure, serious wind erosion damage could be expected.

Texas

MID-APRIL PLANTING GAVE HIGHEST COTTON YIELDS IN 1956

E. D. Cook, Temple.--Since the summer of 1956 was very dry it is not surprising that late cotton gave low yields as shown in the accompanying table. Early cotton probably made better use of the subsoil moisture that was stored during August, 1955, when 13.5 inches of rainfall was received. The yield of both varieties in the test was lower for the April 6 planting than for the April 16 planting. On April 6, mean soil temperature at planting depth was 64°F. By April 16, mean soil temperature was 70°F. These results further indicate cotton should not be planted until soil temperatures exceed 65°F. in order to assure rapid emergence and early growth. When planting was delayed until May, the cotton showed extreme moisture stress before fruiting and gave low yields. The ideal planting date varies from year to year, but 1956 results illustrate that both a cold seedbed and summer drought should be avoided, insofar as possible.

Effect of planting date on yield of two varieties of cotton, Houston Black clay soil, Temple, Texas, 1956

Planting date	Soil temperature at planting depth		Seed cotton yield per acre	
			Variety	
	Minimum	Mean	Lankart	CA 119
	°F	°F	Pounds	Pounds
April 6....................	54	64	1,070	1,200
April 16...................	58	70	1,440	1,480
April 26...................	69	76	1,160	1,360
May 8.....................	72	79	895	1,055
May 25....................	73	80	835	735
L.S.D.			165	145

ROOT-ROT DEPRESSES SOIL ORGANIC MATTER AND NITROGEN

R. J. Hervey, Temple.--Four randomized incipient root-rot infested spots were located in each of two large fields of cotton, one on sloping Austin clay and the other on level Houston Black clay. A similar number of disease-free spots were located. Soil samples were taken at 6-inch intervals to a depth of 24 inches at each of the 16 stations. Analyses for organic matter and total nitrogen were made.

Both the organic matter and total nitrogen contents of root-rot-free soil are perceptibly higher than that of disease-infested soil. In the level Houston Black clay there was little difference at 0-6 inches between diseased and non-diseased soils. Below the six-inch level, however, the differences in both organic matter and nitrogen ranged from about four percent to about 10 percent as the depth increased. In the sloping Austin clay differences between diseased and non-diseased soil did not follow a consistent pattern of increase with depth and the differences in the two were smaller in magnitude. The greatest difference in organic matter content, six percent, occurred at 12-18 inches. Differences in total nitrogen content were small in all cases, with the greatest difference, four percent, being found in the surface six inches.

Houston Black clay in the profile zone of 0-24 inches averaged 16 to 18 percent above Austin clay in organic matter content and 9 to 10 percent higher in total nitrogen.

Data supporting these relationships are shown below:

Soil organic matter and total nitrogen content of root-rot-infested and root-rot-free Austin and Houston Black clays, Temple, Texas

Profile depth	Organic matter content of soil		Total nitrogen content of soil	
	Root-rot infested	Root-rot free	Root-rot infested	Root-rot free
	Austin clay soil on sloping (3-4 per cent grade) land			
Inches	*Percent*	*Percent*	*Percent*	*Percent*
0-6................	2.43	2.52	0.120	0.125
6-12................	2.48	2.50	0.124	0.125
12-18...............	2.21	2.36	0.110	0.114
18-24...............	1.81	1.86	0.088	0.090
0-24................	2.23	2.31	0.110	0.114
	Houston Black clay soil on level land			
0-6................	3.04	3.04	0.141	0.142
6-12................	2.86	2.98	0.131	0.135
12-18..............	2.53	2.69	0.118	0.126
18-24.............	1.99	2.22	0.093	0.103
0-24...............	2.61	2.73	0.121	0.126

Washington

FIRST CUTTING OF ALFALFA FORECASTS TOTAL SEASONAL YIELD

Stephen J. Mech, Prosser.--An analysis of alfalfa hay yields has been made as a bi-product of irrigation experiments conducted over the past several years on Sagemoor fine sandy loam soil at the Irrigation Experiment Station, Prosser, Washington.

This analysis shows that if the first cutting yield of alfalfa hay is low, the total production for the season is low. A high first cutting yield forecasts a high total yield for the season. Information developed from 168 individual yield regressions revealed

alfalfa's uniform rate of dry-matter production between the first and third cuttings, averaging 0.04095 tons per day. Yield data collected at this station during the years 1921-1927 are included to further test the validity of this type of prediction.

Figures 1 and 2 show the wide variation in the first cutting yield and a correspondingly wide variation in the total season yield. The similarity of slope of the cumulative yield curves indicates a uniformity of dry-matter production between the first and third cuttings.
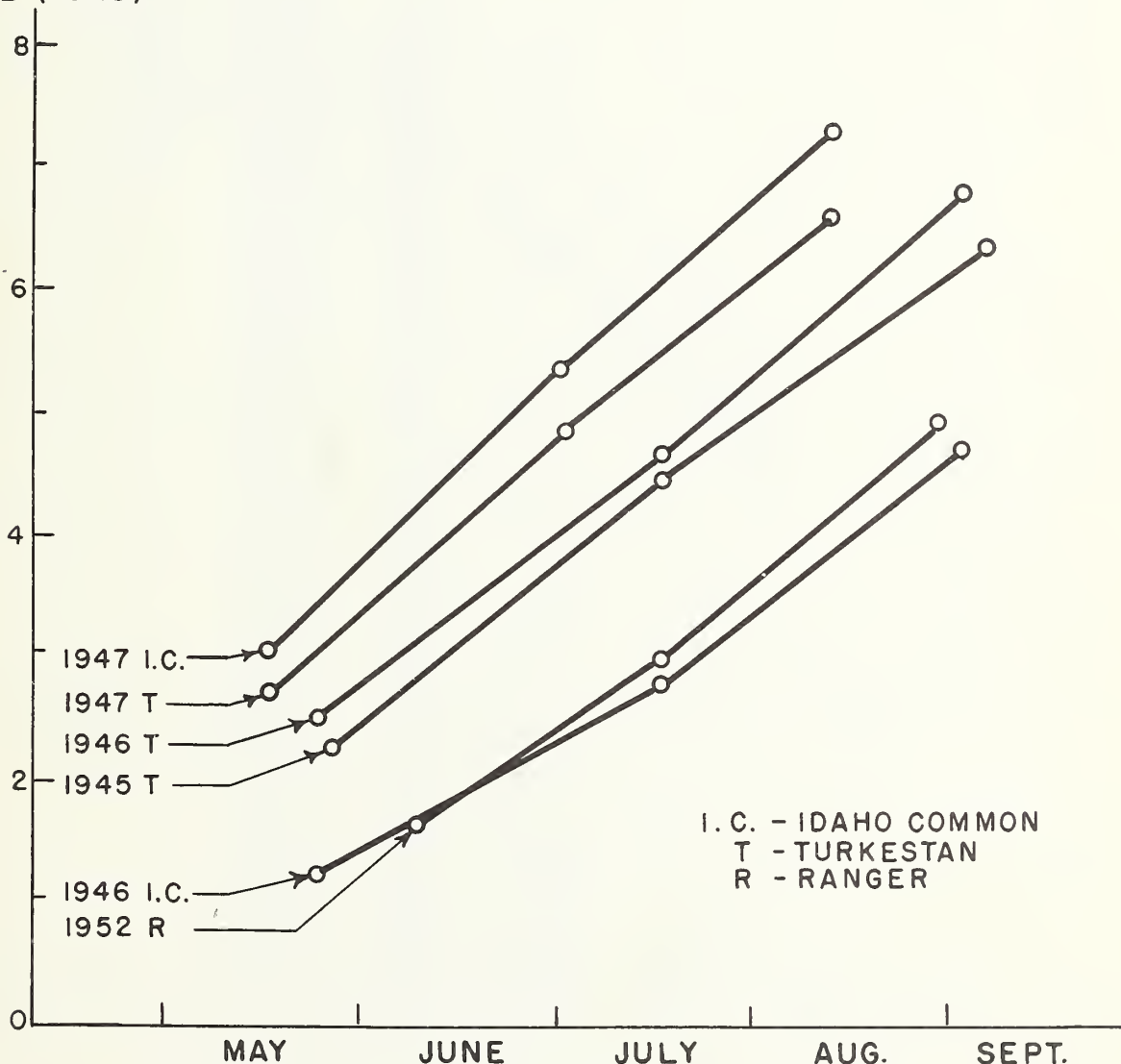
Figure 1. --Cumulative yield of alfalfa on Sagemoor fine sandy loam, Irrigation Experiment Station, Prosser, Wash., 1945-52.

Figure 2. --Cumulative yield of Dakota common alfalfa on Sagemoor fine sandy loam, Irrigation Experiment Station, Prosser, Wash., 1945-52.

California

MAPPING DEPICTS AREAS OF PONDED WATER IN BORDER STRIPS

Norman A. MacGillivray and R. C. Husbands, Merced. --In a study to investigate the relationships between irrigation practices and mosquito production in pastures conducted in cooperation with the California State Health Department of Merced, California, ponded water areas in border strips are being examined for two reasons: (1) to determine intake-opportunity time and (2) to determine the area available for mosquito larvae development and survival. The usual method for determining the location and duration of areas covered by water by means of advance and recession curves was inadequate for purposes of this study. A more suitable method was found to be the drawing of daily maps of the border strip showing, to scale, the areas covered by water. A series of such maps, shown in the following figure, illustrate this method.

DAILY WATER MAPS OF ONE BORDER STRIP FOR ONE IRRIGATION, IRRIGATION MOSQUITO STUDY; MERCED, CALIF.

DAYS AFTER WATER FIRST APPLIED
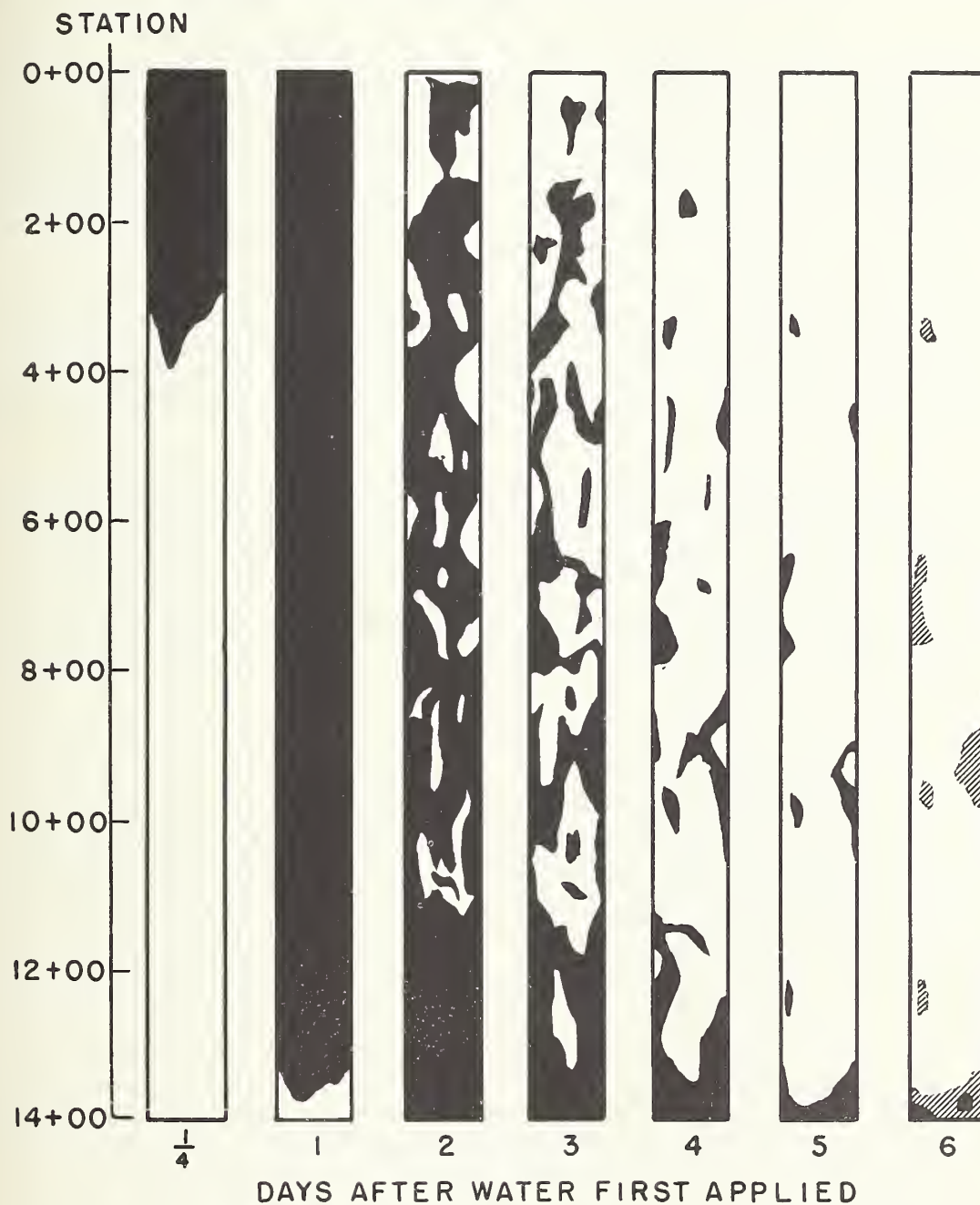
WATER COVERED AREAS

MOSQUITO EMERGENCE AREAS

An examination of the water area maps shows that a determination of intake opportunity time by the usual advance and recession curve process may not give the true mean intake opportunity time for border strips. This fact is of considerable importance when crop damage and mosquito production occur as a result of ponding. The problem is receiving additional study.

HYDROLOGY--GENERAL

<u>Ohio</u>

NUTRIENT LOSSES BY LEACHING VARY WITH RAINFALL

F. R. Dreibelbis and L. L. Harrold, Coshocton, --The amount of water percolating through the soil profile depends, to a great extent, upon the season, amount of rainfall, and the temperature. Large amounts of rainfall, particularly during the winter and early spring, favor a substantial increase in percolation. High temperatures tend to reduce percolation because of the large amount of water removed from the soil by evapotranspiration which process is favored by high temperatures.

When water percolates through the soil it carries with it valuable plant nutrients such as nitrogen, potassium, calcium, and magnesium. Generally, the greater the percolation the greater is the amount of nutrients lost in this manner. Data on the extent of nutrient losses by leaching provide information useful in planning soil management and fertility programs.

Data on average annual losses of K, Ca, Mg, N, Mn, and S in percolates for the period 1940-55 are presented in the accompanying table. Data for 1950 and 1953, years of high and low precipitation, respectively, are also given to show the wide differences in losses under these extremes in rainfall. The data for these years are also summarized to show the influence of soil conservation practices on nutrient losses in percolates.

Plant nutrient losses in lysimeter percolates during periods of high, low and average precipitation. Keene silt loam, Coshocton, Ohio, 1950, 1953 and 1940-55 averages.

Period	Practice	Precipitation		Perco- lation	Nutrients percolated per acre					
		Relative	Total		Ca	Mg	K	N	Mn	S
			Inches	*Inches*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
1950......	Conservation	High	47.28	12.61	51.79	30.18	11.55	5.62	0.64	82.21
1953......	Conservation	Low	28.20	3.54	5.88	.74	2.77	.64	.13	8.28
1940-55...	Conservation	Average	37.16	6.29	29.35	17.61	9.67	3.47	.30	31.42
1950......	Poor	High	47.28	13.40	30.81	18.69	20.56	2.87	.94	51.18
1953......	Poor	Low	28.20	5.04	4.59	.68	3.61	1.18	.19	12.51
1940-55...	Poor	Average	37.16	7.20	21.04	12.29	13.41	4.13	.37	20.89

Nutrient losses during years of high precipitation and high percolation are an example of maximum annual losses when other factors are equal. Fertility practice, soil type, and crop are other major factors influencing nutrient losses. During years of low rainfall and small amounts of percolation, minimum values are obtained. During the year 1950 both rainfall and percolation were much above normal and the data on all of the nutrient losses determined show this is close to the maximum likely to occur under the climatic and fertility conditions prevailing at the Coshocton Station. The annual rainfall amounted to 47.28 inches, over 7 inches above normal. The percolation on Keene silt loam for that year was 12.61 inches, over six inches above the 16-year average. Calcium losses were over 51 pounds per acre which is equivalent to approximately 130

pounds of calcium carbonate. In 1953 the annual rainfall was only 28.20 inches, 11 inches below normal while the percolation was 3.54 inches, about three inches below the 1940-55 average. Calcium losses were only 5.88 pounds per acre compared to 29.35 for the 16-year average. Magnesium losses showed an even greater contrast between the two years. The other elements studied, K, N. Mn, and S, also showed a great contrast in losses between the two years.

In comparing the two practices, losses of Ca, Mg, and S were greater from the conservation practice lysimeter. This was due to the greater amounts of these elements applied in lime and fertilizer. The amounts of K, N, and Mn, in the percolates were greater from the poor practice areas. The influence of lime was effective in reducing K losses due to the repressive effect of limestone on the leaching of K. Nitrogen differences were small between the two practices and the effect of practice was not consistent from year to year on the leaching of nitrogen. Manganese losses were less from the conservation practice lysimeters because of the influence of liming which reduces the solubility of manganese.

The contrast in losses between the two practices was less than the contrast between high and low rainfall years. This point is important under irrigation. If excessive amounts of water are applied in irrigation it is evident that greater nutrient losses through percolation will result. Also, there are times in the humid region when rainfall may quickly follow irrigation. This would tend to increase nutrient losses by leaching because of the excessive water present in the soil due to unexpected rainfall following irrigation.

The data in the table give a good idea of nutrient losses in gravitational water for the soil type and locality represented. Soil type exerts some influence as does the amount of fertilizer, manure, and lime applied.

The amount of nutrients lost in the leaching process are likely less than that lost in surface runoff. Also, nutrient losses by leaching are less than commonly supposed because many of the studies reported in the past were obtained from filled-in lysimeters which had no provision for surface runoff. This tended to exaggerate nutrient losses through percolation.

Texas

INFILTRATION RATES ARE RELATED TO SOIL MOISTURE DEPLETION

Ralph W. Baird, Waco. --One of the most difficult problems associated with predicting storm runoff is that of estimating the soil moisture condition prior to the storm under consideration. One method of making this estimate is to use the rate of moisture dissipation between storms to estimate the amount remaining in the soil at any particular time. This method has particular value in an area with deep, heavy soils that have a high intake capacity when dry but a low intake capacity when wet. A review of a study of soil moisture, rainfall, and runoff relationship indicated information that may be used in a water budget method of estimating soil moisture.

This study used measurements of soil moisture, rainfall and runoff for several years on a number of small watersheds of about 3 acres each at the Blacklands Experimental Watershed. The deep soils of this area, when dry, have the capacity to rapidly absorb large quantities of water. Infiltration and permeability rates are very small when the soil is wet. Very little, if any, water penetrates to groundwater supplies.

Under these conditions a fair estimate of the amount of water used for crop production can be made from a series of soil moisture, rainfall and runoff measurements. Measurements of soil moisture were made at regular intervals to a depth of five feet. Evapotranspiration was computed for a given period as: the change in soil moisture plus the rainfall less the surface runoff. Other studies in this area indicate that the volume of water transmitted to groundwater is very small. At times some water was contributed to soil moisture increases below the 60 inches sampled but these and other unmeasured losses are assumed to be a small percentage of the total water available.

To determine the amount of water various crops could use and the time of this use, the totals of soil moisture changes plus rainfall minus runoff were computed and plotted at each sampling period. The results of these observations are shown for cotton in Figure 1. The periods of low use were those when moisture was not available for plant growth, when no plants were growing, when plants were becoming established or were dormant. It was assumed that the maximum rate of use for any seasonal period approximated the rate for maximum production. By assembling all the maximums, a use curve was developed which should approach the maximum this crop could use under these climatic, soil and crop conditions. Maximum use curves were developed for the major crops of the area, Cotton, corn, oats, and native grasses and are shown in Figure 2.
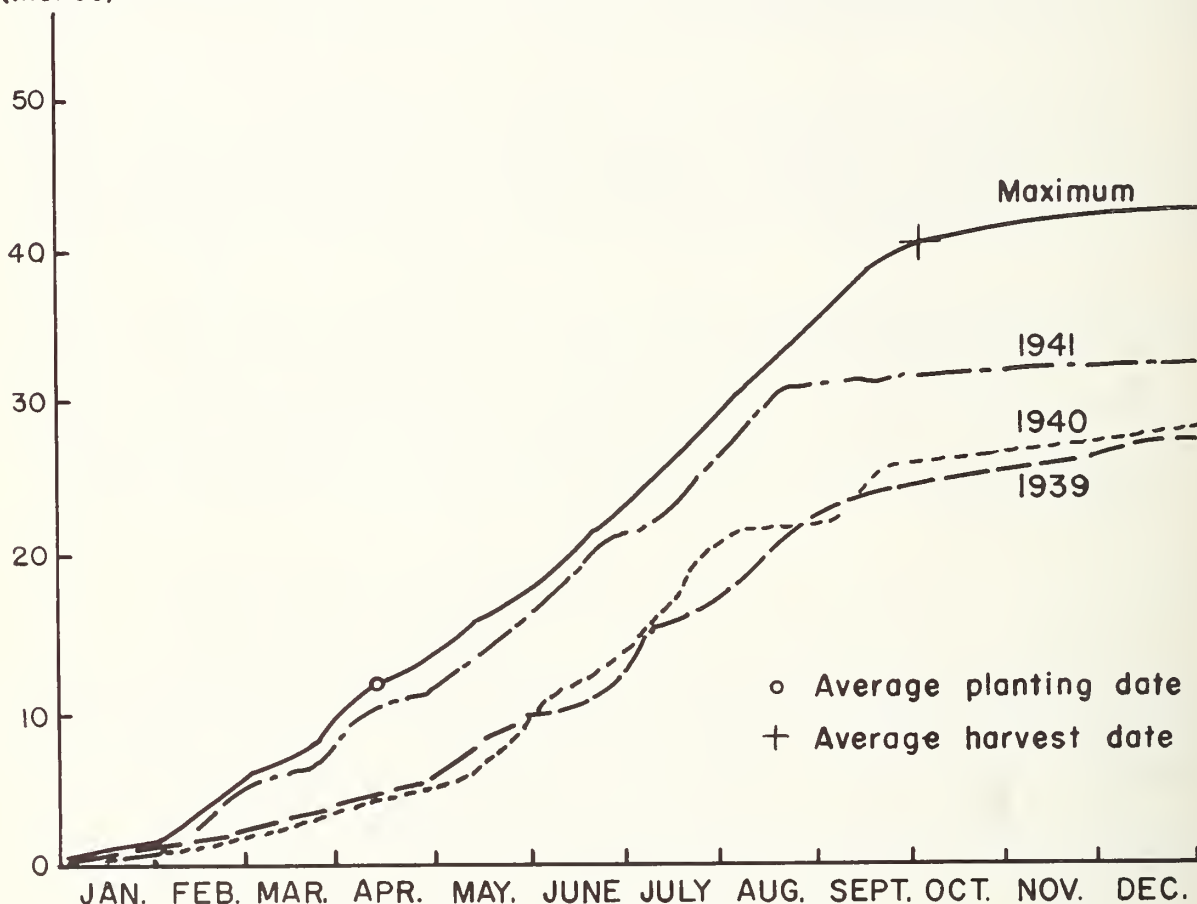

Figure 1. --Soil moisture dissipation by cotton, Blacklands Experimental Watershed, Riesel (Waco), Texas.

From a record of rainfall amounts, estimates of runoff and these maximum curves of evapotranspiration it should be possible to determine whether soil moisture is increasing or decreasing over any period of time and probably make a fair estimate of the amount of the change.
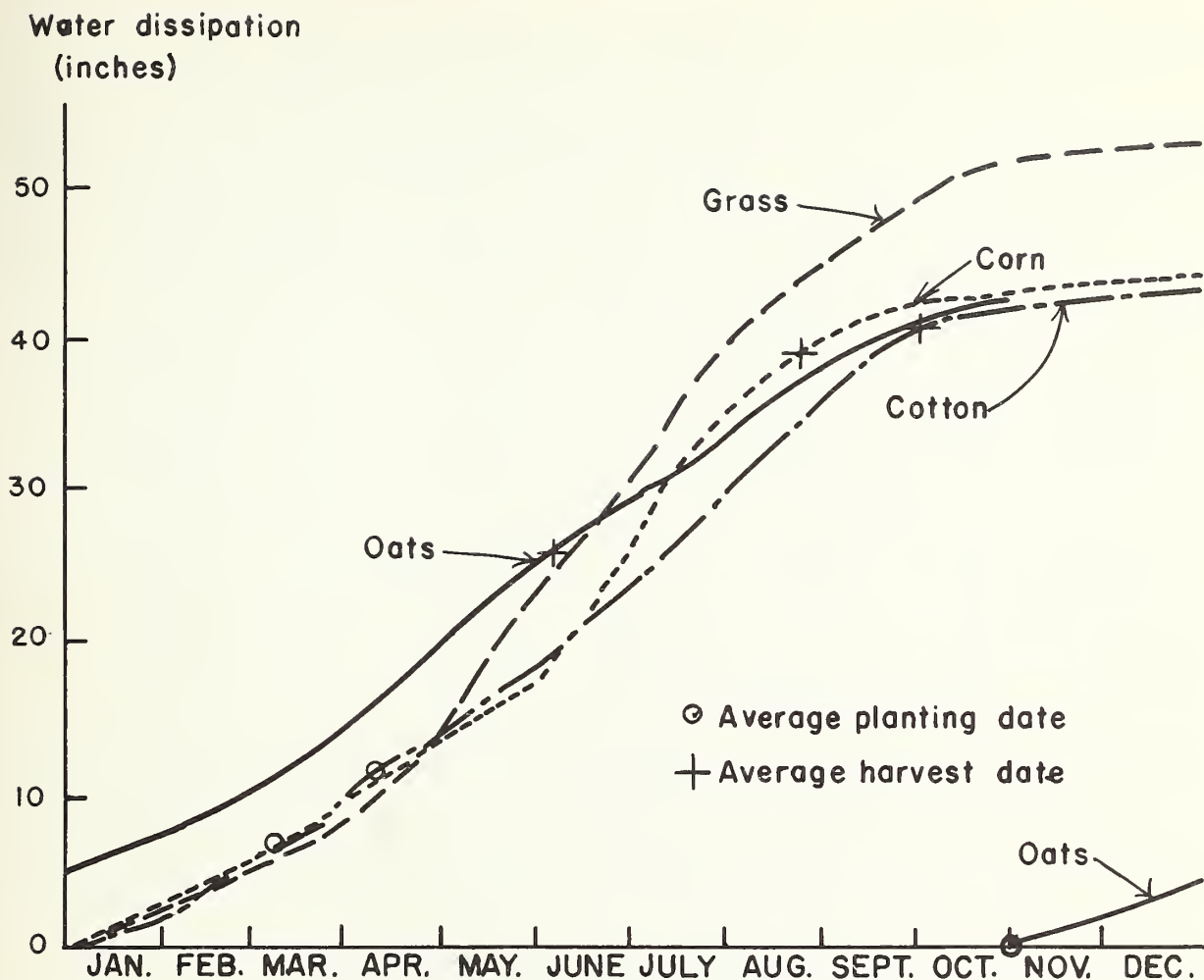
Figure 2. --Maximum soil moisture dissipation by cotton, corn, oats, and native grass, Blacklands Experimental Watershed, Riesel (Waco), Texas.

Texas

LARGE PART OF ANNUAL RUNOFF OCCURS IN ONE HOUR

Ralph W. Baird, Waco. --Percent of annual runoff from area W-1 occurring in various time intervals is summarized in the attached table. The tabulated runoff is the maximum which occurred during the year for the indicated time interval. One of the interesting things in this summation is the large average percentage of annual runoff that occurred during relatively short periods. An average of almost 1/4 of the annual runoff occurs in one hour. As indicated in yearly tabulations, there is a tendency for larger percentages to occur in the years of relatively small runoff.

The area of W-1 is 176 acres without any special conservation practices and has been continued with the same land use throughout the period of record.

Maximum percent of annual runoff occurring during various time periods and total annual runoff by years, Area W-1, Blacklands Experimental Watershed, Waco, Texas, 1938-55

Year	Maximum percent of annual runoff occurring in indicated number of hours						Total annual runoff
	1	2	4	24	48	168	
	Percent	Percent	Percent	Percent	Percent	Percent	Inches
1938.......	8.18	11.36	16.97	43.91	44.34	45.89	4.35
1939.......	27.50	33.02	34.79	35.10	35.21	72.60	.96
1940.......	19.77	22.76	24.49	36.40	60.73	65.20	9.20
1941.......	15.02	16.41	16.76	16.99	17.35	19.57	12.02
1942.......	11.95	13.10	13.53	19.86	24.53	24.64	11.51
1943.......	28.65	30.81	32.43	35.25	35.41	35.81	1.48
1944.......	14.07	26.21	30.23	33.19	43.30	52.04	21.25
1945.......	6.70	8.26	9.20	18.85	19.14	19.71	12.60
1946.......	18.11	23.22	25.78	34.25	34.44	44.39	8.55
1947.......	6.02	10.89	15.67	24.44	26.93	31.88	4.62
1948.......	29.65	41.05	45.85	51.22	51.27	51.35	2.29
1949.......	43.41	49.95	51.61	52.29	52.29	52.39	2.05
1950.......	46.79	55.33	61.21	66.06	66.73	68.67	1.65
1951.......	23.82	37.94	50.59	55.00	55.00	55.88	.34
1952.......	21.51	26.42	31.73	43.80	44.58	44.64	1.79
1953.......	17.00	17.16	24.43	28.66	31.76	56.79	4.33
1954.......	58.99	71.07	74.09	75.41	82.39	82.45	1.59
1955.......	40.26	43.74	44.60	49.91	49.96	49.96	2.35
Total......	437.40	538.70	603.96	770.59	775.36	873.86	102.93
Average....	24.3	30.0	33.6	40.1	43.2	48.6	5.72

HYDROLOGY--LAND USE INFLUENCES

North Carolina

RUNOFF PATTERN INFLUENCED BY COVER

James B. Burford, Blacksburg, Va.--Short term rainfall-runoff records for two watersheds located near Statesville, North Carolina, indicate that watershed covers influence the runoff patterns. These two watersheds are designated as C-8, a 5.12 acre, unterraced, cultivated watershed, and W-23, a 6.01 acre, wooded watershed. The following table summarizes the rainfall-runoff data for the individual storms which caused maximum annual peaks from watershed C-8.

These data point out the contrast between the maximum peaks discharges and the duration of runoff for the two watersheds for a given storm. The runoff patterns for C-8 have high peaks and short duration as compared to those from W-23, which have low peaks and long duration. These two watersheds are about 0.6 miles apart and received very similar rainfall patterns for the selected storms.

Date	Watershed[1]	Rainfall	Runoff Peak discharge per hour	Runoff Duration	Runoff Total	Watershed cover
		Inches	Inches	Minutes	Inches	
8/18/33	C-8	1.30	4.57	336	1.12	Oat stubble and weedy lespedeza 5" high
	W-23	1.02	0.05	605	0.06	Wooded, litter 1-1/2" to 2" deep
6/23/34	C-8	1.68	0.30	71	0.10	Lespedeza and weeds drilled 4/13/34
	W-23	1.72	0.05	345	0.04	Wooded, litter 1-1/2 to 2" deep
7/14/35	C-8	2.53	3.64	148	1.81	Cotton planted 4/19/35
	W-23	2.13	0.05	368	0.07	Wooded, litter 1-1/2" to 2" deep
4/6/36[2]	C-8	2.86	1.28	1276	0.83	Rye and vetch, sown 10/12/35
	W-23	2.85	0.11	3757	1.11	Wooded, litter 1-1/2" to 2" deep
7/6/37[2]	C-8	2.02	3.93	135	1.14	3" lespedeza in oat stubble
	W-23	1.45	0.07	655	0.04	Wooded, litter 1-1/2" to 2" deep
6/20/38	C-8	3.09	2.57	260	1.62	Lespedeza
	W-23	2.72	1.25	1570	1.85	Following cutting operation during winter 1937-38

[1] C-8--5.123 acres; Cecil clay loam predominates; average slope, 7%; maximum flow distance, 825 ft.

W-23--6.005 acres; Applying sandy loam; average slope, 18%; maximum flow distance, 756 ft.; heavy, virgin, mixed stand of hardwood and pine prior to winter of 1937-38, then a conglomeration of tops, broken saplings and a scattering of small trees with stump diameters less than 8 or 9 inches. This area had never been burned.

[2] This storm did not give the maximum annual discharge peak for W-23.

A summary of the six years of records indicates that there was very little difference in the average annual runoff from these two watersheds. For C-8, and W-23, respectively, 10.38% and 12.00% of the total precipitation was measured as runoff. The summary follows:

	Watershed	
	C-8	W-23
Area (Acres)...	5.123	6.005
Length of Record (Years).............................	6	6
Annual Precipitation (Inches)		
Maximum...	63.17	63.17
Minimum...	34.78	34.78
Average...	49.01	49.01
Annual Runoff (Inches)		
Maximum...	8.42	10.98
Minimum...	1.44	1.58
Average...	5.09	5.88
Average runoff as percent of average precipitation..	10.38	12.00
Peak discharge for period of record (Inches/hour)...	4.57	1.25

CONSERVATION PRACTICES AFFECT EROSION AND RUNOFF

F. R. Dreibelbis and L. L. Harrold, Coshocton.--Data on surface runoff and erosion from corn watersheds in 1952 and 1956 are given in the accompanying table. Five different practices are represented, (1) poor practice, consisting of low fertility and straight rows; (2) conservation practice consisting of high fertility and contour cultivation; (3) same as (2) plus strip cropping; (4) mulch culture consisting of high fertility, contour cultivation, plus disking and retention of plant residues on surface and upper part of plow layer; (5) plow-plant system consisting of one cultivation only in which the corn is planted at the same time the plowing of the second year meadow takes place.

Both surface runoff and erosion values were considerably higher on the poor practice watershed, the erosion amounting to over 7 tons per acre for the growing season in 1956. By contrast, soil loss from the contour cultivated area with high fertility was only 1.1 tons per acre. The strip-cropped watershed lost less than 1/2 ton per acre, while the mulched area and the plow-plant areas had the least erosion, amounting to 111, and 52 pounds per acre respectively. Similar results were obtained four years ago when these watersheds were in corn. Plow-plant practice was first used in 1956.

Annual records on runoff and soil loss for the year 1952 are also given showing similar results obtained in both corn years. While contour cultivation alone does reduce runoff and erosion, the marked reductions are obtained by strip-cropping, mulch culture, and by the plow-plant system of growing corn.

Surface runoff and erosion on watersheds in corn, Coshocton, Ohio, May - September, 1956

Month	Watershed number, area, and practice				
	No. 106 1.56 acre Poor practice	No. 121 1.42 acre Contour Cult.	No. 185 7.40 acre Strip-crop	No. 188 2.05 acre Mulch culture	No. 191[1] 1.20 acre Plow-plant
	Surface runoff--inches				
May.........	0.15	0.17	0.15	0.06	.01
June........	.79	.44	.18	.04	.01
July........	2.08	1.02	1.02	.35	.21
August......	.58	.04	.09	0	.01
September....	.05	0	.01	0	0
Total 1956...	3.65	1.67	1.45	.45	.23
Total 1952...	2.83	1.12	.14	.05	.01
	Soil loss--pounds per acre				
May.........	336	38	17	21	0
June........	2,450	1,105	169	29	Tr
July........	10,959	1,054	772	61	52
August......	401	11	8	0	Tr
September....	39	0	0	0	0
Total 1956...	14,185	2,208	966	111	52
Total 1952...	17,239	3,207	85	65	20

[1] Plow-plant in 1956; 1952 contour cultivation plus soil-conditioner.

RUNOFF AFFECTED BY LAND USE

John A. Allis, Hastings.--A preliminary analysis of average annual runoff was made on 24 single-crop watersheds approximately 4-acres in size for the period 1946 to 1954. The cultivated watersheds cover 3 cycles or a 9-year period in a corn, oats, wheat rotation. These are the same watersheds discussed in the Quarterly Report No. 8. The following table shows the average annual runoff for the three crops in each practice and the average runoff for the complete rotation for the various practices. The nine-year average annual runoff is given for the meadow and pasture watersheds.

Average annual runoff for 24 approximately 4-acre watersheds, Hastings, Neb., 1946-54

Practice	Runoff			
	Corn	Oats	Wheat	Average
	Inches	Inches	Inches	Inches
Straight Row......................	4.80	4.13	4.59	4.51
Contoured.........................	2.86	3.26	3.61	3.25
Subtilled.........................	3.73	3.68	4.02	3.81
	Pasture and meadow watersheds			
Meadow............................	-----------	-------	-------------	.42
Pasture...........................	-----------	-------	-------------	2.20

SEDIMENTATION

NEW FORMULAE PRESENTED FOR COMPUTING VOLUMES DISPLACED BY DAMS

Herman G. Heinemann, Lincoln.--USDA, Technical Bulletin No. 524, Silting of Reservoirs, gives formulae for calculating the results of reservoir sedimentation surveys which are now in general use for the range method of survey. Formulae presented include those for calculating V_o, which is the volume displaced by the upstream face of the dam. Study of the most probable shapes of the displaced volumes suggests that more refined estimates of V_o for individual reservoirs can be made by giving consideration to the characteristics of the impounding dam and valley in which it sits. The general shapes of volumes displaced by dams with and without berms in "V" and "U" shaped valleys are indicated by Figures 1 through 12.

In "V" shaped valleys a half view of the section of a dam having no berm has an appearance similar to that of Figure 1. This figure also shows the sediment volume displaced by the dam. Figure 2 is an end view of such a dam with the sediment deposited on the upstream face also shown. Figure 3 is a diagram of the sediment deposited on the face of the dam. If the dam in a "V" shaped valley has a berm on the upstream face then half views as shown by Figures 4, 5, and 6 apply instead of the first three figures.

In a "U" shaped valley a half view of the section of a dam having no berm has an appearance similar to Figure 7. This figure also shows the sediment volume being displaced by the dam. Figure 8 is an end view of such a dam, with the sediment deposited on the upstream face also shown. Figure 9 is a sketch of the sediment deposited on the face of the dam. If the dam in a "U" shaped valley has a berm on the upstream face, then half views Figures 10, 11, and 12 apply instead of 7, 8, and 9.

RESERVOIR SEDIMENTATION SURVEYS -"V" SHAPED VALLEY
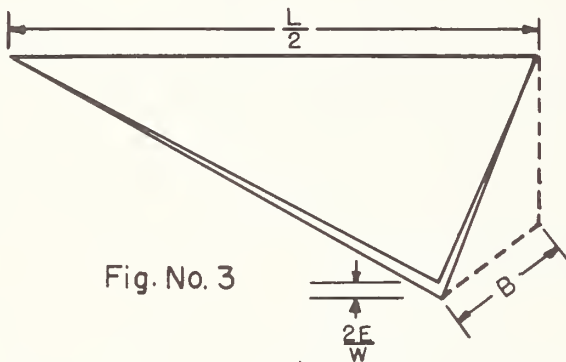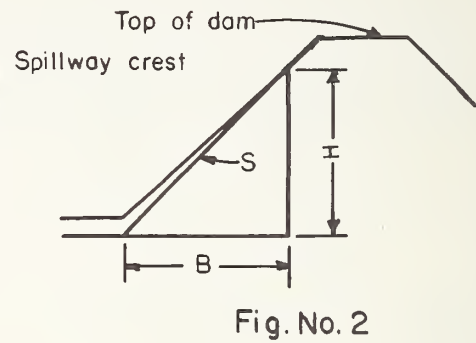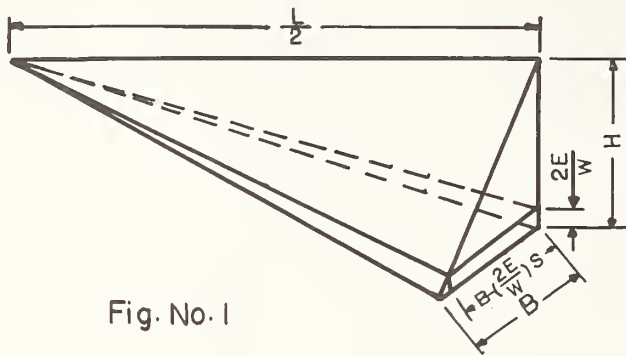
Fig. No. 1

Fig. No. 2
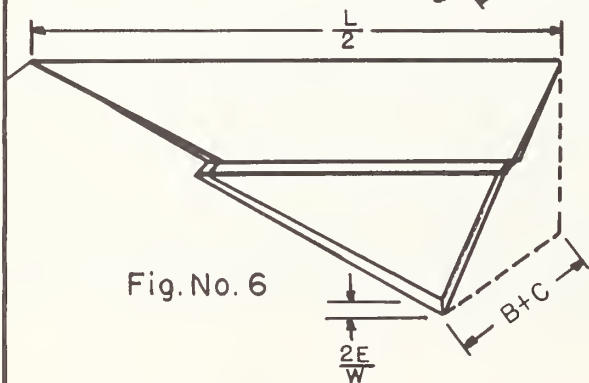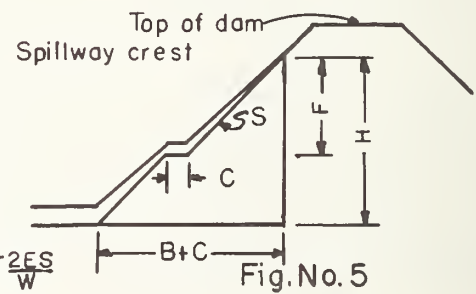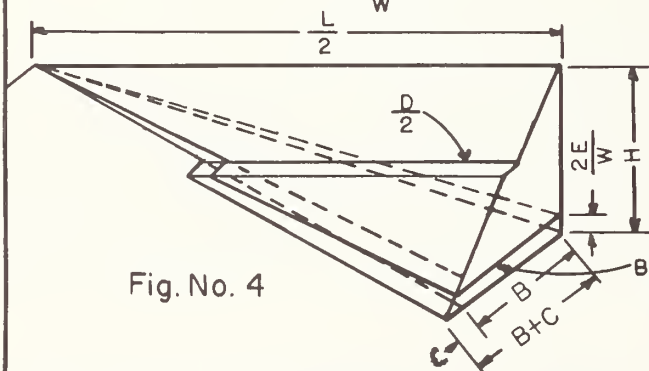
Fig. No. 3

Fig. No. 4

Fig. No. 5

Fig. No. 6

RESERVOIR SEDIMENTATION SURVEYS-"U" SHAPED VALLEY
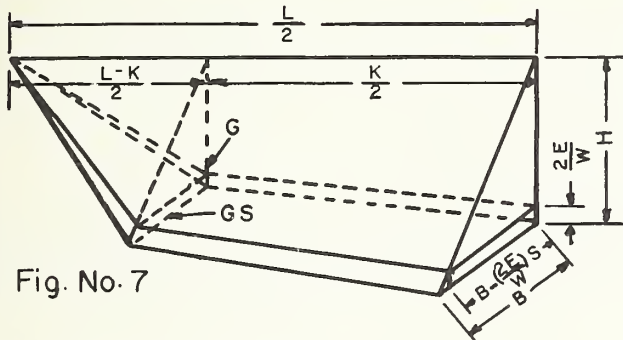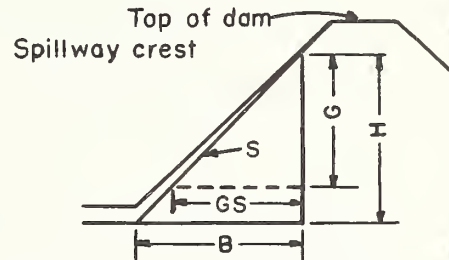

Fig. No. 7

Fig. No. 8
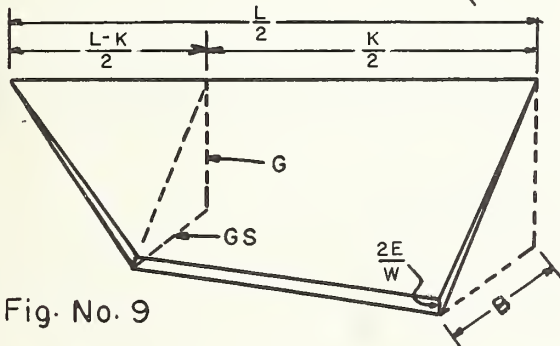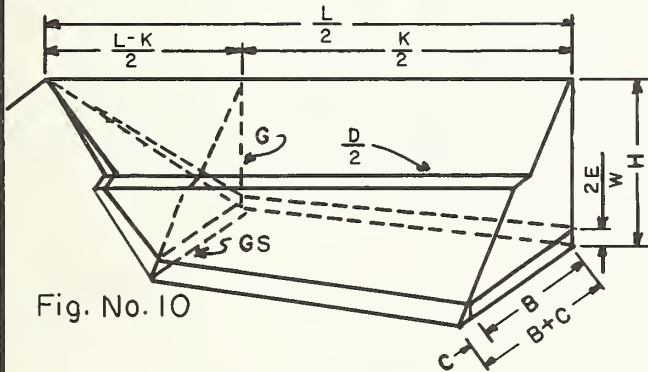
Fig. No. 9

Fig. No. 10

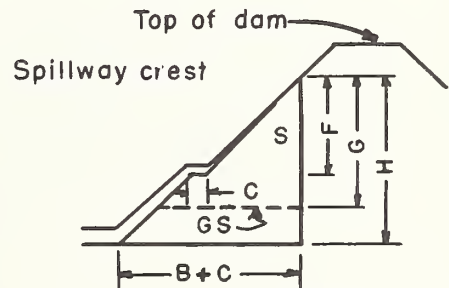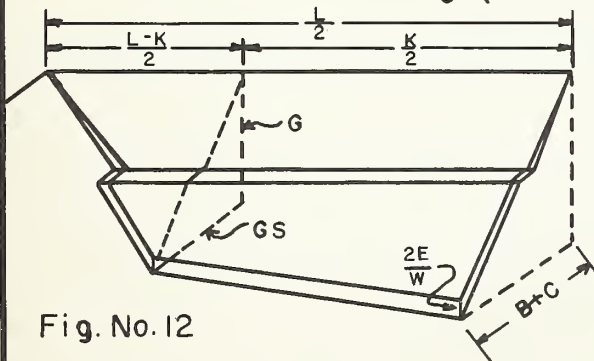Fig. No. 11

Fig. No. 12

The following symbols are used in Figures 1 through 12 and the formulae:

B = Horizontal distance from the upstream toe of dam to the deepest point on the original bottom directly below spillway crest line, in feet. B also equals HS.

C = Width of berm, in feet.

D = Length of berm from one valley side to the other valley side, in feet.

E = The cross-sectional area, in square feet, of original capacity or sediment volume cut by a bounding range.

F = Vertical distance from spillway crest to the top of the berm, in feet.

G = Vertical distance, in feet, in a "U" shaped valley between the spillway crest and original valley floor at the point near the side of the valley where the valley floor changes slope rapidly from one predominantly horizontal to that approaching the vertical.

H = Maximum vertical distance from original bottom to spillway crest line, in feet.

K = Horizontal length of valley floor, in feet, between the sides of the "U" shaped valley--the horizontal distance along the reservoir line between the points of changing slope defined under "G".

L = Length of dam at reservoir crest elevation, in feet.

S = Horizontal component of the slope ratio of the upstream face of the dam. Thus, when the slope ratio is 2:1, S=2; and for a 3:1 slope, S=3, etc.

V = Original capacity or sediment volume, in cubic feet.

W = Width (length of bounding range) at crest elevation, in feet.

$\frac{E}{W}$ = Average depth of a bounding range, in square feet. In making sediment volume calculations $\frac{E}{W}$ represents the average depth of sediment. Because sediment depth is assumed to vary as the depth of the reservoir for segment No. 1, the thickness at the greatest depth equals $\frac{2E}{W}$.

The following formulae for calculating V_O in cubic feet are suggested. To obtain acre feet divide by 43,560.

"V" Shaped Valley

The original capacity and sediment volume for the segment next to the dam which has only one range and the face of the dam will be computed by the formula shown in Technical Bulletin No. 524, namely $V = A\frac{E}{W} - V_O$.

For dams without a berm on the upstream face, the original capacity displaced is calculated by $V_O = \frac{HBL}{6}$. Refer to Figures 1 and 2.

For the calculations to determine the sediment volume displaced by a dam without a berm, $V_O = \frac{EL}{3W}(\frac{B-2ES}{W})$. Refer to Figures 1, 2, and 3.

It is assumed here that sediment depth on the face of the dam varies with water depth. Since $\frac{E}{W}$ represents average depth of sediment, the sediment at the greatest depth equals $\frac{2E}{W}$.

On dams having a berm on the upstream face, the original capcity displaced by the dam and berm is calculated by the formula, $V_o = \frac{HBL}{6} + \frac{CD(H-F)}{2}$. Refer to Figures 4 and 5.

For the calculations to determine the sediment volume displaced by a dam with a berm, $V_o = \frac{E}{W} \left(\frac{LB}{3} - \frac{2ELS}{3W} + CD - \frac{FCD}{H} \right)$. Refer to Figures 4, 5, and 6.

"U" Shaped Valley

The formulae are the same as for the "V" shaped valley except for the segment next to the dam. The original capacity and sediment volume for this segment next to the dam, which has one range and the face of the dam acting as the other range, will be computed by the formula $V = A\frac{E}{W} - V_o$.

For dams without a berm on the upstream face, the original capacity displaced by the dam is calculated by $V_o = \frac{K}{4}(HB + G^2S) + \frac{G^2S(L - K)}{6}$. Refer to figures 7 and 8.

For the calculations to determine the sediment volume displaced by a dam having no berm, $V_o = \frac{EK}{2W} \left(B - \frac{2ES}{W} \right) + \frac{E}{W} \left(\frac{G^2S}{H} \right) \left(1 - \frac{2E}{HW} \right) \left(\frac{K + 2L}{6} \right)$. Refer to Figures 7, 8, and 9.

For dams having a berm on the upstream face, the original capacity displaced by the dam can be calculated by $V_o = \frac{KBH}{4} + \frac{G^2S}{} \left(\frac{K}{12} + \frac{L}{6} \right) + \frac{CK}{2} (H + G - 2F) + \frac{(G-F)(D-K)C}{2}$. Refer to Figures 10 and 11.

For the calculations to determine the sediment volume displaced by a dam with a berm on the upstream face,
$$V_o = \frac{EK}{2W} \left(B - \frac{2ES}{W} \right) + \frac{E}{W} \left(\frac{G^2S}{H} \right) \left(1 - \frac{2E}{HW} \right) \left(\frac{K + 2L}{6} \right) + \frac{CE}{W} \left(K + \frac{DG}{H} - \frac{KF}{H} - \frac{DF}{H} \right).$$
Refer to Figures 10, 11, and 12.

HYDRAULICS

<u>Colorado</u>

STUDY STARTED ON DESIGN OF VORTEX TUBE SAND TRAPS

A. R. Robinson, Fort Collins. --There is a great need for a device to remove sediment from irrigation canals in order to prevent deposition in the canals and on irrigated lands. The vortex tube sand trap has proven to be an effective device for this purpose. However, there are very little design data available for this type of device.

This project consists of two distinct phases. One is a laboratory study using a large tilting flume to determine the basic fundamentals of the vortex tube operation. The other consists of a field evaluation of existing vortex tube installations.

The laboratory phase of this study is now under way. A vortex tube test section has been installed in a laboratory testing flume. A sediment-water mixture will be recirculated through the flume. Data will be obtained on the design of the section for maximum trapping efficiency over a normal range of operating conditions.

LIST OF RECENTLY PUBLISHED PAPERS AND PUBLICATIONS

Some of the recently published papers and publications written solely or jointly by staff members of the Soil and Water Conservation Research Branch are listed below.

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